7.0 FINAL RECOMMENDED ALTERNATIVE

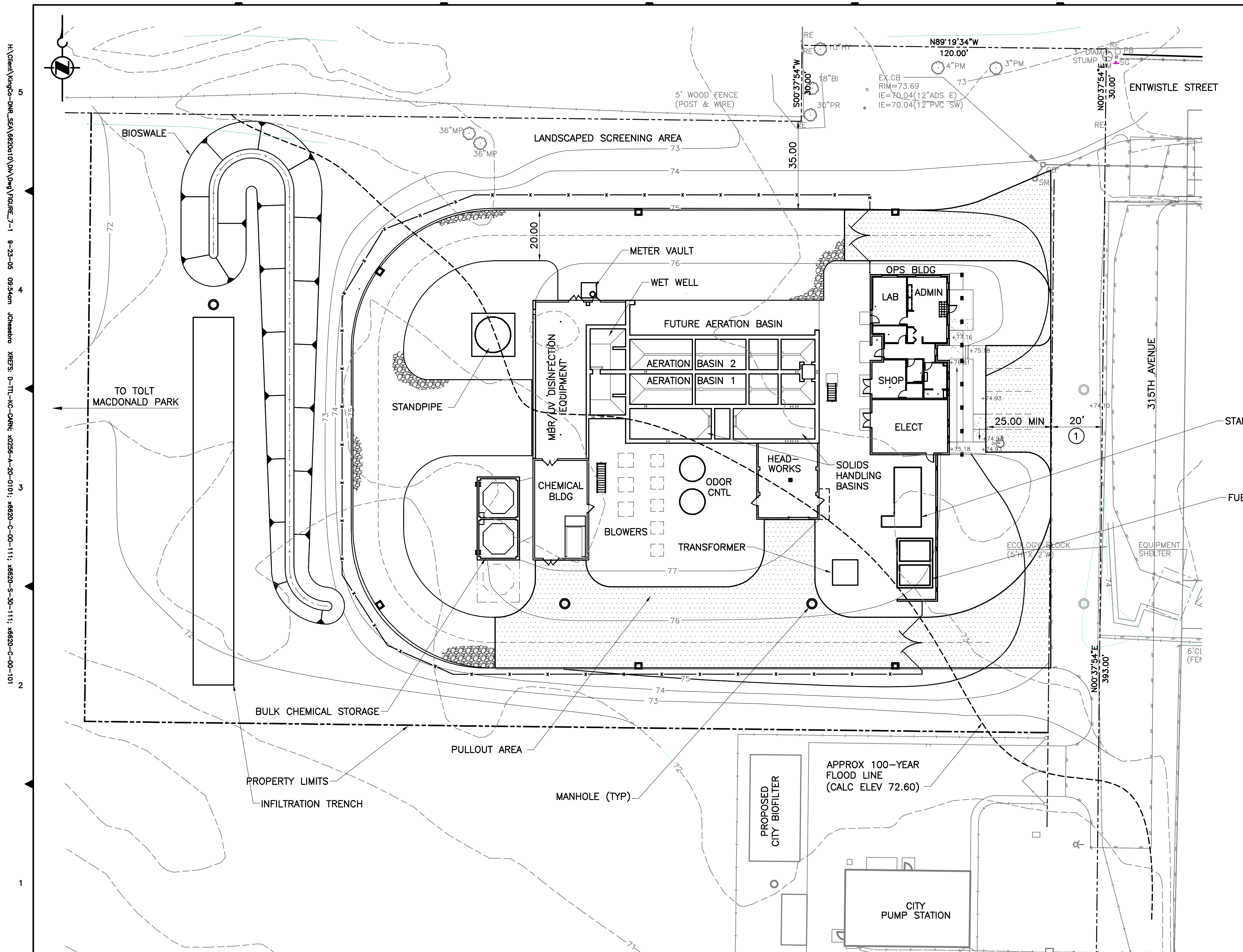
7.1 Recommended Treatment Facility Site

In Fall 2004, the Executive selected the City-owned site as the location for the new CWWTF. The recommended site was selected based on a number of considerations including: 1) the environment, 2) cost, 3) engineering, 4) community impacts, and 5) County policy associated with capital and O&M. The City-owned site will not require acquisition of land from a private entity or additional pumping between the vacuum pump station and the CWWTF headworks. The County is in negotiations to purchase as much as two acres of property, with the facilities being located on approximately 0.6 acres of land, located outside of the current 100-year floodplain. The City and County will be involved in discussions to come to an agreement for long-term use of the CWWTF site area. The City-owned site is zoned for light industrial and manufacturing use. Based on Title 15 of the City's municipal code,[255] manufacturing, processing, repairing, and assembling establishments are permitted in these areas. Although sewage treatment is an industrial process, the City requires a Conditional Use Permit be procured for the CWWTF to be constructed within this zone.

For the new CWWTF, the County will strive to achieve a building design that substantially reduces negative environmental impacts. Leadership in Energy & Environmental Design (LEED®) concepts can be followed to address environmental and worker comfort issues such as machine clearances, acoustics, and day lighting. Design of the facility in a "green" manner can reduce the overall operating costs, increase worker productivity, and reduce potential indoor air quality problems.

Initial site planning has been compatible with LEED® design concepts, and the incorporation of cost-effective green engineering elements will be continued in detailed design efforts. The proposed architectural appearance of the buildings at the site has been developed so that the facilities will blend in with the surrounding area, existing structures, and landscaping. To accomplish this, the taller (two-story) structures will be located to the rear of the site, away from other land parcels. The single-story operations building will be aligned parallel and adjacent to the roadway. Figure 7.1 provides a preliminary layout of the CWWTF.

The CWWTF will be separated into three facility/operations areas: 1) operations building; 2) headworks, activated sludge basins, and solids holding; and 3) MBR, UV disinfection, and chemical feed facility. The operations building, located on the east end of the site, includes the administrative office, restroom facility, laboratory, electrical room, and



GENERAL NOTES:

1. VERTICAL ELEVATIONS ARE BASED ON NAVD 88 DATUM.
2. SURVEY TAKEN ON DECEMBER 14, 2004 BY ROTH HILL ENGINEERING PARTNERS, LLC.

KEY NOTES:

1. ADDITIONAL 20' CITY RIGHT OF WAY, TO BE VERIFIED.

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED: JPC	CHECKED:
DRAWN: BJE	SCALE: 1"=20'
RECOMMENDED:	
APPROVED:	CONTRACT NO: E23020E

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.1

RECOMMENDED WWTF SITE PLAN

DATE:	SEPT, 2005
FILE NO:	423557/###
DRAWING NO:	
SHEET NO:	OF

maintenance workshop. The headworks will be south of the activated sludge basins and solids holding basins at the center of the facility site. The MBR, UV disinfection, and chemical feed structures will be located west of the activated sludge and solids holding basins. Space is available at the far west end of the facility for a potential 24-hour onsite storage tank if the wetlands discharge alternative is selected. Based on preliminary discussions, stormwater originating at the treatment facility site will be treated through a bioswale and directed to subsurface disposal.

7.2 Recommended Discharge Location

Based on the results of the environmental review and cost considerations in Fall 2004, the Executive directed County staff to carry forward the river outfall and wetlands discharge alternatives for further study. As documented in the EIS[256] and other previous reports, the upland discharge to groundwater alternative was eliminated as an option based on available hydrogeology information, environmental review, and cost considerations. Although wetlands enhancement of the SWA offers an opportunity to use reclaimed water from the CWWTF to enhance wildlife habitat, preliminary estimates place the alternative at approximately $2.2 million more than the river outfall discharge alternative. This alternative also presents other logistical and technical issues, such as permitting certainty within the time needed for plant operation. Design and permitting activities will proceed with the river outfall discharge alternative as shown in Figure 7.2, but the County will continue to actively pursue potential partnerships and grants to make wetlands enhancement an environmental amenity and an economically viable future reuse opportunity for this project. Additional opportunities to enhance wetlands closer to the CWWTF are also currently being evaluated to beneficially provide habitats in a cost conscious manner. The CWWTF design flexibility will allow the facility to be easily retrofitted to meet the Washington State reclaimed water standards,[257] should the County be interested in applying highly treated water for reuse applications in the future. If the wetlands alternative becomes technically, logistically, and financially feasible, the County will prepare an amendment to the Facilities Plan.

Three alternative discharge locations along the Snoqualmie River were evaluated prior to the EIS as possible outfall locations:[258] 1) Near the Tolt MacDonald Park, 2) At the Carnation Farm Road Bridge, and 3) Chinook Bend.

A review and confirmation of the selected outfall location on the Snoqualmie River was completed in order to address public comments and to refine project costs. This later evaluation consisted of a review of previously available information for the Park and Bridge locations, recent river cross-section profiles at the two locations, and detailed fisheries data on the TDR of the Snoqualmie River. The Chinook Bend location was not re-evaluated as the other two sites offered considerable advantages. The County's assessment of the relative risk of the two discharge locations to salmonids is provided in Appendix G. Table 7.1 summarizes the evaluation parameters and potential impacts associated with each alternative outfall location.

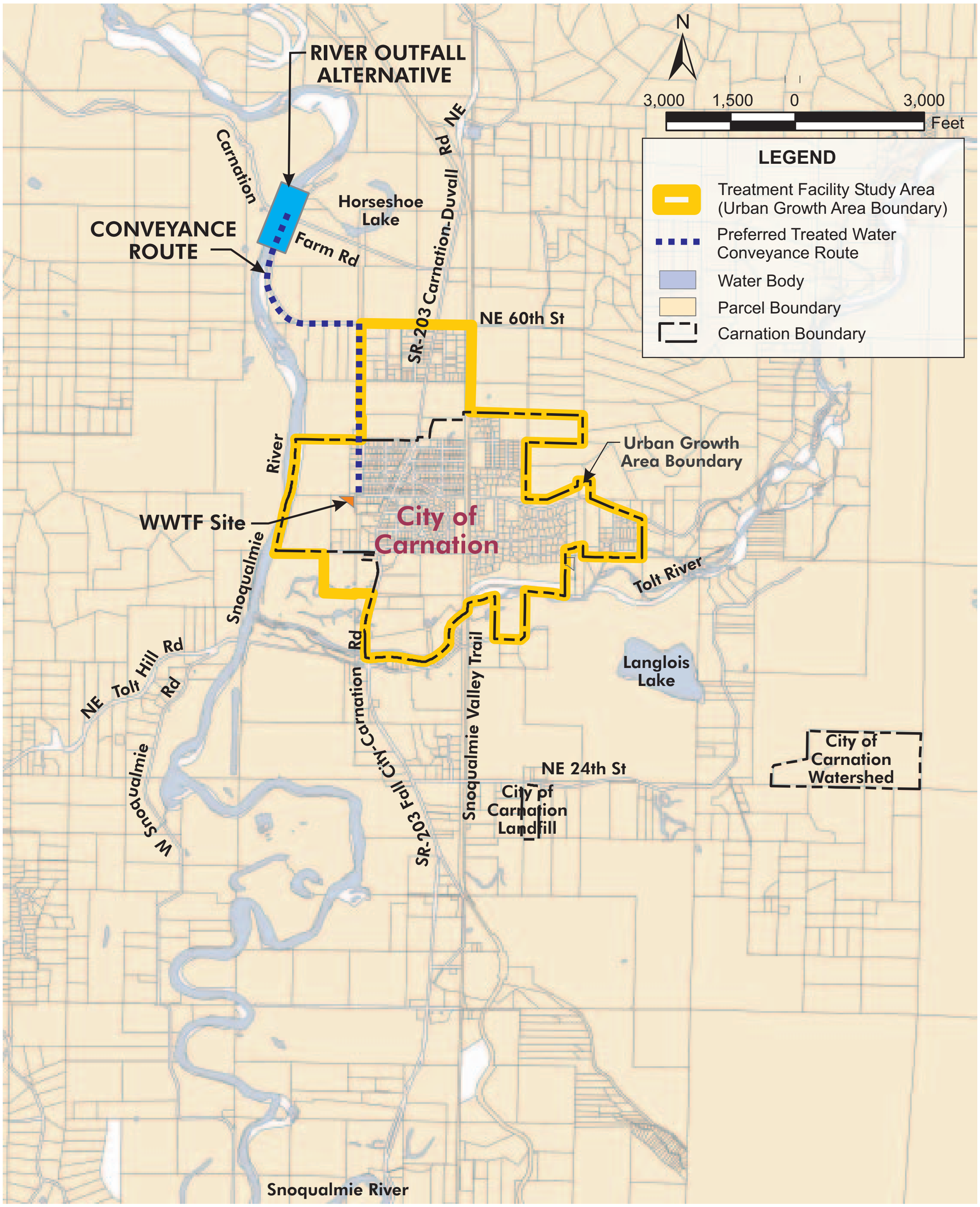


Figure 7.2
RECOMMENDED EFFLUENT DISCHARGE SYSTEM
CARNATION WASTEWATER TREATMENT FACILITY
KING COUNTY DEPARTMENT OF
NATURAL RESOURCES AND PARKS

H:\Client\KingCo-DNR_SEA\6620a10\Dlv\Facility_Plan\Figures\car305f1-6620.cdr

Table 7.1 Snoqualmie River Outfall Location Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Carnation Farm Road Bridge		Tolt MacDonald Park	
	Rank	**Evaluation**	**Rank**	**Evaluation**
Fisheries[259,260,261]	+	The number of documented Chinook redds is lower than at the Park stretch of river (75.3 redds/mile). The reach lies downstream of the highest concentration of spawning grounds based on available detailed data.	-	The stretch has the highest density of Chinook redds per mile (86.5) for the Snoqualmie River. It accounts for roughly 30% of the total number of redds observed and 20% of the spawning Chinook.
Operational water quality impacts [262,263,264]	+	The highly treated water from the CWWTF would have no measurable effects (as required by regulation) on the existing river quality (including temperature, nutrients, and metals) beyond the anticipated allowable acute and chronic mixing zones. Based on the lower identified fish density, habitat impacts within the allowable mixing zones would be lower than at the Park. Conveyance to the Bridge would increase the amount of time available for the subsurface to cool the highly treated water.	-	Historical fisheries data show probable concentrated spawning and rearing within the potential allowable mixing zones. The relative habitat impacts within the allowable mixing zones in this area would potentially be higher (but may remain minimal) than areas further downstream. Conveyance to the Park would result in a shorter period of time available for subsurface cooling of highly treated water.
Construction impacts (in water and near shore) [265,266,267,268]	+	A vertical pipe mounted to the downstream side of the western bridge pier would convey the highly treated water to the mixing zone. The alternative would require minimal in-water and near-shore work. Construction methods and shorter work schedule decrease the sedimentation and turbidity impacts to the river. The alternative would result in negligible to no disturbance of river bottom.	-	The discharge point would be closer to the deep pool on the east side of the river. In-water work and bed disturbance would be required. There is concern of the potential impact to fish in the area by NOAA Fisheries. Potential impacts would be short term (4 weeks) and may include increased sedimentation of spawning gravels, increased turbidity, and accidental release of pollutants from construction equipment. The river velocities would disperse the impacts downstream.

Table 7.1 Snoqualmie River Outfall Location Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Carnation Farm Road Bridge		Tolt MacDonald Park	
	Rank	Evaluation	Rank	Evaluation
Channel migration due to WRIA 7 bank destabilization project	O	Long-term stability would likely not be impacted by the downstream bank destabilization project.[269] The County has an existing commitment to maintain the Bridge as part of the County's infrastructure.	O	Not an issue at this location.
Bank stability at discharge location[270]	O	The identified location is an area with a historically stable channel based on aerial photos from 1938 to 2002. The conveyance pipeline could be affected during flooding. Previously, flooding has caused a local washout of the County roadway adjacent to the Bridge. The County has an existing commitment to maintain the Bridge and its roadways.	O	The identified location is an area with a historically stable channel based on aerial photos from 1938 to 2002. The conveyance pipeline could be affected during flooding.
Permitting	+	Location would eliminate certain federal and state permit requirements (Section 404 and 401). The location is downstream of the identified prime spawning areas and would not disturb the river bed. The lesser requirements could possibly lead to a reduction in the current permit schedule.	-	Location would require complex federal (Section 404 and Section 7) and state HPA and Section 401) permits. The location does not appear to avoid or minimize impacts to waters of the state as required by Section 404 CWA, and NEPA, WAC 173-26-201, and SEPA regulations.
SEPA review	+	The environmental impacts of locating the outfall at the Bridge have been addressed in the final EIS.[271] There would be no impact on the current SEPA schedule.	-	The environmental impacts at locating the outfall near the Park have not been fully identified and therefore require additional SEPA review. Changing the location of the outfall may require an addendum to the EIS (potentially delaying the SEPA schedule by 4 to 6 months) or a supplement to the EIS (potentially delaying the SEPA schedule by 6 to 8 months).

Table 7.1 Snoqualmie River Outfall Location Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Carnation Farm Road Bridge		Tolt MacDonald Park	
	Rank	**Evaluation**	**Rank**	**Evaluation**
Public outreach process	**+**	Outreach to the river outfall property owners near the Bridge is underway. The SEPA public process requirements have been fulfilled.	**-**	The Park is a regional park with many facilities and used year-round. To date, public outreach activities have not focused specifically on either park or recreational users of the river. Additional public outreach would be required due to the change in outfall location and would reopen the SEPA public process. The redirection would require additional resources and potentially impact the project schedule.
Public opinion	**O**	Public outreach, to date, has indicated broad support for the wetlands enhancement project at SWA. Public opinion about a river outfall has been mostly negative, particularly from property owners near the Bridge and environmental organizations.	**O**	The opinions of the City's residents and public at large have not been solicited for this location. It is likely that both existing groups and park and recreational users of the river not yet identified would argue against the Park outfall location.
Other benefits	**+**	The location supports a potential phased approach to wetlands restoration to the north.	**+**	The conveyance distance to the Park outfall is shorter than the distance to the Bridge outfall. The construction costs and time required to install the pipeline (excluding the outfall structure) would be less than those for the Bridge location.

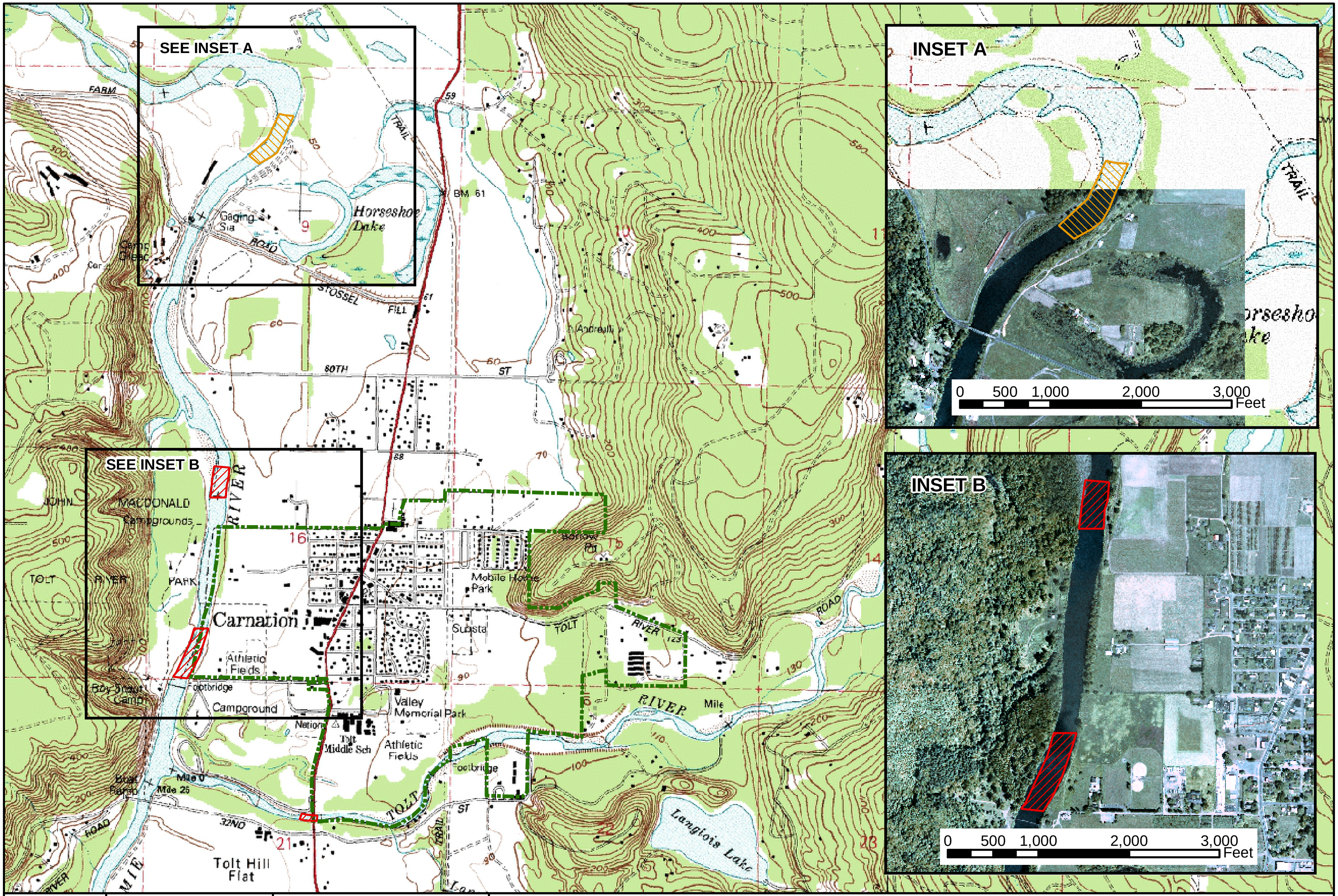
+ = more favorable
O = negligible difference in favorability
- = less favorable

Bridge = Carnation Farm Road Bridge
CWA = Clean Water Act
EIS = Environmental Impact Statement
HPA = Hydraulic Project Approval
NEPA = National Environmental Policy Act
NOAA = National Oceanic and Atmospheric Administration
Park = Tolt MacDonald Park
SEPA = State Environmental Policy Act
WAC = Washington Administrative Code

The State of Washington has designated the Snoqualmie River as “Salmon and Trout Spawning, Core Rearing, and Migration” waters from RM 9.1 to the headwaters of the South Fork.[272] The headwaters mainly originate in the Alpine Lakes Wilderness in the central Cascade Mountains,[273] east of the City. The City is located on the TDR of the Snoqualmie River and lies within this pristine stretch of river. The TDR lies between RM 20.5 and RM 24.9 and is a high-quality habitat used by nine species of salmonids.[274] Chinook, chum, and pink salmon and steelhead trout are documented to use the area at moderate to very high spawning densities. Chinook and steelhead rear in this reach for up to one and two years, respectively. Spawning activities in this area have not been documented for coho salmon, cutthroat trout, and mountain whitefish, but it is expected they are likely to rear and migrate extensively within the TDR. Bull trout activity most likely includes foraging, migration, and over-wintering. Sockeye are present, but their abundance and usage is uncertain.

The TDR exhibits high-quality characteristics for juvenile Chinook rearing, including moderate to high velocities and large pools and riffle pocket-water with extensive cobble and small boulder substrates. The condition of the freshwater habitat may be of special importance for the Snoqualmie stock because the juveniles exhibit a relatively high (upwards of 30 percent) proportion of “stream-type” behavior, in which juveniles spend upwards of a year in freshwater. In contrast, most Puget Sound Chinook populations are dominated by the “ocean-type” juvenile behavior, in which juveniles spend a relatively short time (three months) in freshwater. As a result, the Snoqualmie Chinook may have a higher reliance on freshwater habitat conditions than do other Puget Sound Chinook stocks. There are no definitive studies as to why the Snoqualmie Chinook exhibit this behavior or whether they use Snoqualmie habitats or the TDR reach preferentially.

WDFW has documented the TDR as an index area to assess salmon spawning and run size abundance for several decades.[275] The reach has the second highest six-year average and density of Chinook spawning nests, or redds, of the six main stem river reaches surveyed by WDFW. Based on 2004 surveys, Chinook spawning between the mouth of the Tolt River and the Bridge (86.5 redds/mile) has a higher redds density than the 1.5-mile stretch downstream of the Bridge (75.3 redds/mile). Figure 7.3 illustrates the redd locations from three boat survey dates in 2004 between the mouth of the Tolt River and the Bridge and air survey observations downstream of the Bridge. Data at this scale were not available from previous years for the purpose of comparison. However, data at a larger scale and information from WDFW suggest that the pattern is indicative of other years as well.[276] The limited detailed data (from 2004) within the TDR shows three main clusters of redds located: 1) at the footbridge at the Park and extending about 1,500 feet downstream, 2) approximately 4,200 feet from the footbridge and extending approximately 800 feet downstream, and 3) approximately 1,500 feet from the Bridge and extending approximately 1,000 feet downstream.[277] The data collected do not describe the absolute or relative densities found within each cluster.



File name: redds.mxd/reddsFig1.pdf
Created/last edited by: KH
Date last updated: 02/25/05

N

1:28,000

Map data are the property of the sources listed below. Inaccuracies may exist, and Adolfson Associates, Inc. implies no warranties or guarantees regarding any aspect of data dipiction.

ADOLFSON

High Redd Densities - Source:

- 2004 WDFW Boat Survey
- WDFW Air Survey Observations
- Carnation City Limits

FIGURE 7.3

WDFW CHINOOK REDD OBSERVATIONS
CARNATION WASTEWATER TREATMENT FACILITY

7.2.1 Tolt MacDonald Park

The river area (approximately at RM 24) near the Park had been identified as an area with a wide bed and a slight bend. The riverbanks have a solid foundation and are steep, riprapped to the east, and gravelly to the west.[278] A river survey profile taken in 2005 shows that the optimal location for the outfall discharge at this location would be in the deep pool on the east bank as shown in Figure 7.4. The discharge pipe would be reduced from a 12-inch HDPE pipe to an eight-inch ductile iron pipe with a diffuser check valve extending approximately 20 feet into the river. The pipeline installation would likely require sheet piling or a temporary dam during in-water construction.

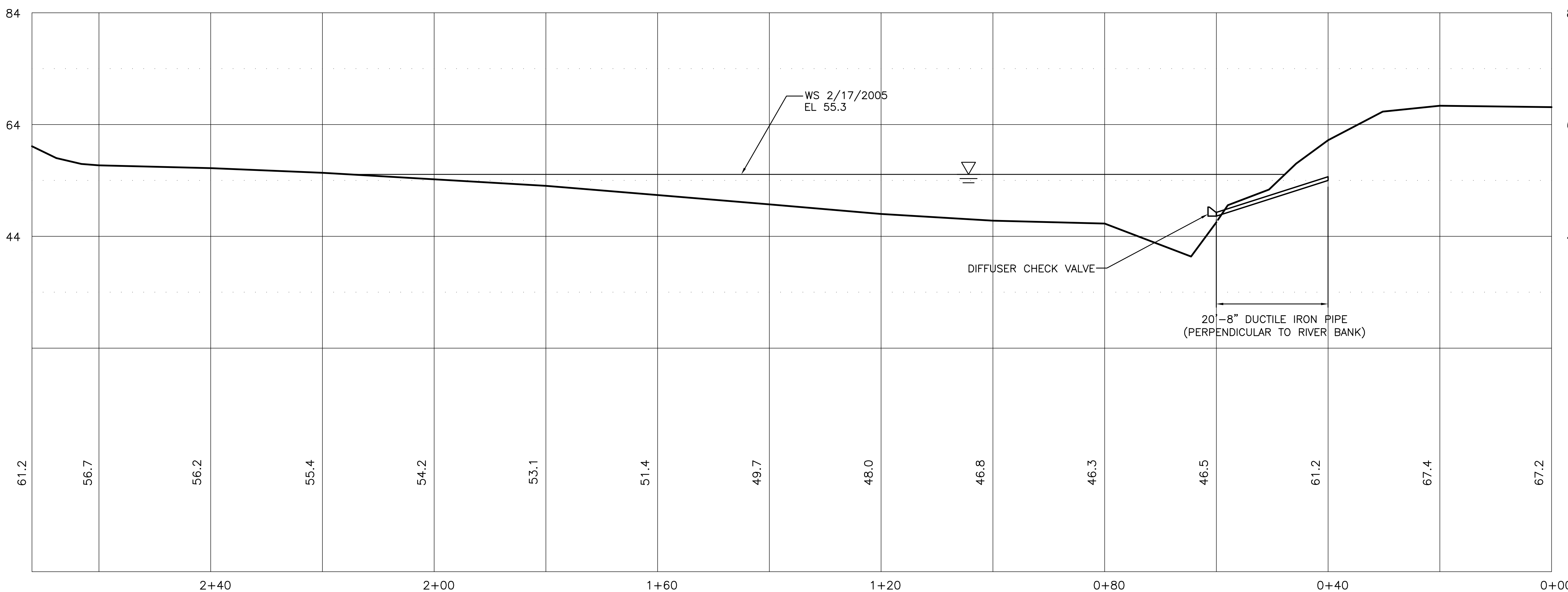
7.2.2 Carnation Farm Road Bridge

The Bridge location (between RM 22 and RM 23) had also been identified as an area with a wide bed but also has a bridge, footings, and piers. River survey profiles taken in 1950 and 2005 confirm that minimal scouring and sediment deposition have occurred at the west bridge pier over the last 55 years. Overall, the riverbed has been stable at this location. The optimal location for the outfall discharge would be in the deep pool close to the west bank as shown in Figure 7.5. In order to reach the deep pool of the river, several construction methods were evaluated. Laying the discharge pipeline across the width of the Snoqualmie River to reach the deep pool area would cause extensive and prolonged in-water disruptions due to construction. An alternate configuration would be to support the discharge pipeline across the Bridge to the west pier. The bridge pier would continue to provide support as the pipeline enters the water. A diffuser check valve would provide a downspout-type outfall.

The Bridge is a registered historical landmark. Any construction efforts would require a Certificate of Appropriateness from the Landmark Commission, which demonstrates that the alternative will have the least overall impact to the area. Initial discussions with the County's Roads Services Division have indicated that a seismic retrofit of the bridge was completed in 1997. Two three-inch pipelines are already attached to the bridge. A feasible option discussed with the County's Roads Services Division includes using the bridge to structurally support an additional eight- or ten-inch ductile iron discharge pipeline for the CWWTF.

GENERAL NOTES:

1. VERTICAL ELEVATIONS ARE BASED ON NAVD 88 DATUM.
2. RIVER PROFILE TAKEN FACING DOWNSTREAM, 20' SOUTH AT NORTH SIDE OF TOLT MACDONALD PARK.
3. PROFILE TAKEN ON FEBRUARY 17, 2005 BY PENHALLEGON ASSOCIATES CONSULTING ENGINEERS.



RIVER PROFILE

SCALE: 1'= 20'

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

SCALE: 1"=20'

carollo engineers

DESIGNED/DRAWN: SEF	SCALE: NONE
PROJECT ENGINEER: SML	
DESIGN APPROVAL:	
FINAL APPROVAL:	CONTRACT NO: C_____C

KING COUNTY

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.4
SNOQUALMIE RIVER PROFILE NEAR TOLT MACDONALD PARK

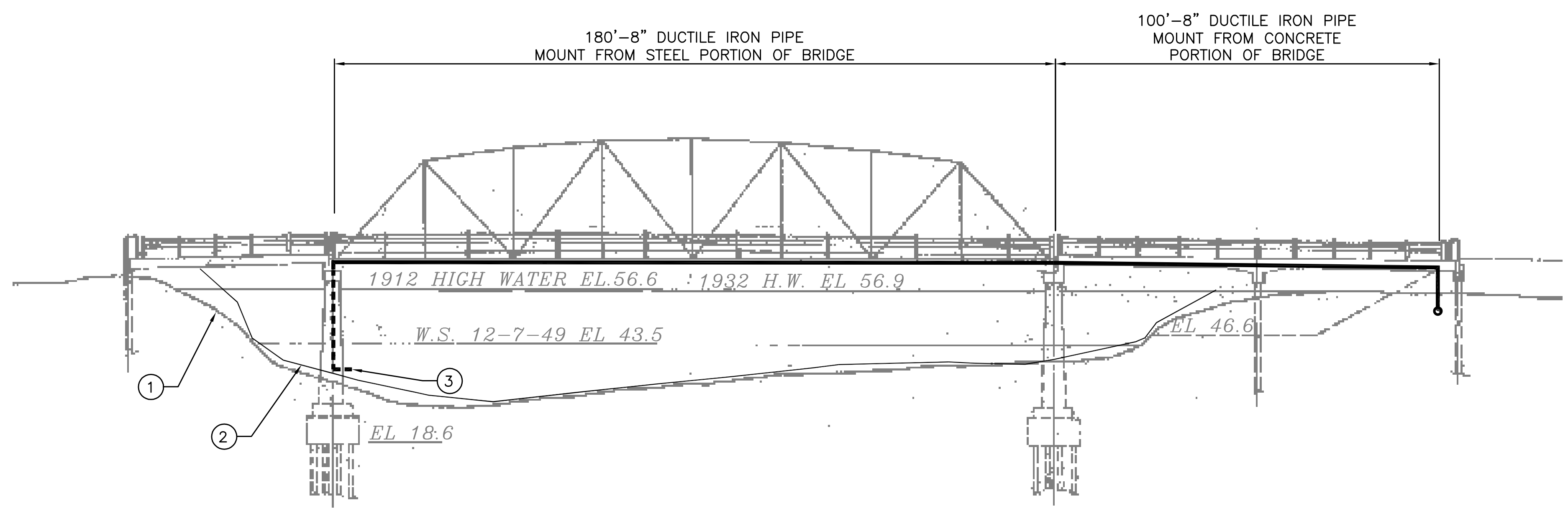
DATE:
FILE NO: 423528/###
DRAWING NO:
SHEET NO: OF

Last Saved By: TAS 3-11-05 02:35pm

H:\Client\KingCo-DNR_SEA\6620a10\Div\Dwg\FIGURE_7.5 3-11-05 02:36pm sfroker XREFS: BRIDGE_ELEV.

KEY NOTES:

1. CARNATION FARM ROAD BRIDGE AND RIVER PROFILES PREPARED IN APRIL 1950. ELEVATIONS SHOWN ARE BASED ON NAVD 88 DATUM.
2. RIVER PROFILE TAKEN AT 20 FEET NORTH OF NORTH SIDE OF CARNATION FARM ROAD BRIDGE ON FEBRUARY 17, 2005 BY PENHALLEGON ASSOCIATES CONSULTING ENGINEERS.
3. PROTECTED 8" DIFFUSER CHECK VALVE.



BRIDGE ELEVATION
AND RIVER PROFILE

SCALE: 1" = 40'

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED/DRAWN: SEF	SCALE: NONE
PROJECT ENGINEER: SML	
DESIGN APPROVAL:	
FINAL APPROVAL:	CONTRACT NO: C______C

KING COUNTY

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.5
RIVER PROFILE AND
OUTFALL AT BRIDGE

DATE:
FILE NO: 423528/###
DRAWING NO:
SHEET NO: OF

7.2.3 Cost Comparison

Costs shown in Table 7.2 compare construction and related allied costs. The costs do not account for other tangible and intangible costs related to the difficulty of permitting and construction at the discharge location. Conveyance from the City-owned site to a discharge point near the Park is less than 15 percent of the distance to the Bridge. In addition, conveyance to the Park is not anticipated to require easements or traffic control because the pipeline would be conveyed along the north edge of a park currently owned by the County. As a result, the overall cost of conveyance to the Park will cost approximately $1 million less than conveyance to the Bridge.

Table 7.2 Cost Comparison of Snoqualmie River Discharge Locations
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Description	Carnation Farm Road Bridge ($)	Tolt MacDonald Park ($)
Capital Costs		
Installed trench	748,000	75,000
River outfall structure	184,000	181,000
Mechanical valves and appurtenances	50,000	20,000
Estimating contingency	99,000	28,000
Contractor overhead and profit	162,000	46,000
Sales tax	109,000	31,000
Easement allowance	38,000	0
Subtotal	1,390,000	381,000
Allied Costs		
Consultant services	258,000	217,000
County administration and other allied costs	100,000	100,000
Subtotal	358,000	317,000
Total Cost (February 2005 dollars)	1,748,000	698,000

7.2.4 Conclusion

The combination of technical, scheduling, environmental and permitting parameters evaluated in Table 7.1 affirms that the Bridge discharge location is preferred over the Park discharge location. Although the cost comparison of the two discharge locations shows a $1 million total cost savings for the Park discharge, the comparison does not account for other potential increased project and cost impacts. For example, the conveyance cost and schedule savings associated with the Park alternative may be exceeded by costs related to the more complex in-water construction, additional environmental review, and more difficult permitting requirements. Conversely, discharging the highly treated water at the Bridge would decrease the exposure risk to areas and densities of documented Chinook and steelhead redds based on 2004 data.[279]

By attaching the discharge pipe directly to the Bridge structure, the amount and duration of in-water construction would be minimized and thus also minimize the impact to sensitive habitat by not disturbing the existing riverbed. With a nominal habitat impact, the United States Army Corps of Engineers (USACE) would not be required to review and issue a CWA Section 404 permit; thereby simplifying the number of regulatory approval processes prepared by the County.

In addition, the County proposes to install a single diffuser valve for discharge of the highly treated water. As compared to traditional multi-port diffusers, a single diffuser valve can provide for a cost-effective means of consistently achieving high initial dilution within the river while generating less headloss at peak flows. The valve design also prevents the intrusion of sand, mud, debris, or river water back into the diffuser pipe, which can accumulate and cause blockage within the pipe. With a variable orifice, the valve optimizes the diffuser hydraulics for the full range of flows by inherently enhancing jet velocities. Figure 7.5 shows that there has been negligible river channel migration at the Bridge in the past 55 years, and the deep river pool has remained stable.

7.3 Recommended Conveyance Route

A review and confirmation of the selected conveyance route to the Snoqualmie River was completed in order to address public comments and to refine project costs. Three alternative conveyance routes to the Bridge were initially identified during preliminary design efforts, as detailed in TM No. 14.[280] Two routes have been selected for review in this chapter. The routes avoid traversing areas that serve as major city thoroughfares, attempt to provide the most direct conveyance route to the discharge location, and minimize construction disruption impacts to the community. Most of either conveyance route from the City-owned site to the river discharge lies within existing public rights-of-way within areas zoned for urban reserve, rural area, agricultural, and open space. Therefore, no zoning changes would be required for the CWWTF location or conveyance or at the river outfall area.

Route A – Route A was the recommended alternative during preliminary evaluation. The route begins at the City-owned site and continues a short distance east on Entwistle Street. The route then heads due north along Stewart Street to the Bagwell Street intersection and continues north along the UGA boundary to NE 60th Street. Heading west on NE 60th Street (which becomes 310th Avenue NE as the route heads northward) the pipeline continues to the outfall located at the Bridge.

Route B – Route B begins at the City-owned site and continues a short distance east on Entwistle Street. The route then heads due north along Stewart Street to the Bagwell Street intersection and continues north along the UGA boundary to NE 60th Street. The route continues to the north to connect with Carnation Farm Road through privately owned property and travels west on Carnation Farm Road to the outfall located at the Bridge. Based on a site visit by the County with the property owner and property tenant of the privately owned property on March 15, 2005, the pipeline would be installed along the remnants of an abandoned railroad line. Three areas along the railroad elevation embankment that had been excavated were visible during the visit. The route passes through a stream along Carnation Farm Road. The pipeline would be required to be supported by a small concrete bridge overhead or tunneling under the stream.

Figure 7.6 illustrates Routes A and B and Table 7.3 provides a detailed comparison.

The discovery of jurisdictional wetland(s) in excavated areas on the privately owned property between NE 60th Street and Carnation Farm Road and a stream crossing on Carnation Farm Road could increase the cost of the alternative Route B as well as delay the SEPA permitting schedule. Therefore, Route A has been confirmed as the proposed route with a lower risk to unforeseen costs and schedule impacts. Crossing the large excavated areas would require construction of costly bridge-type structures as well as approval of regulatory Section 404 and 401 permits.

7.4 Recommended Wastewater Treatment Design

Figure 7.7 provides an overall schematic of the facility process.

7.4.1 Discharge Requirements

Table 7.4 summarizes the main anticipated discharge requirements for the CWWTF. Table 4.2 of this document lists the minute quantities of other toxins, such as metals, which are also regulated by the Surface Water Standards.[281] These anticipated requirements are also anticipated to satisfy the TMDL recommended loading capacity for the Snoqualmie River.

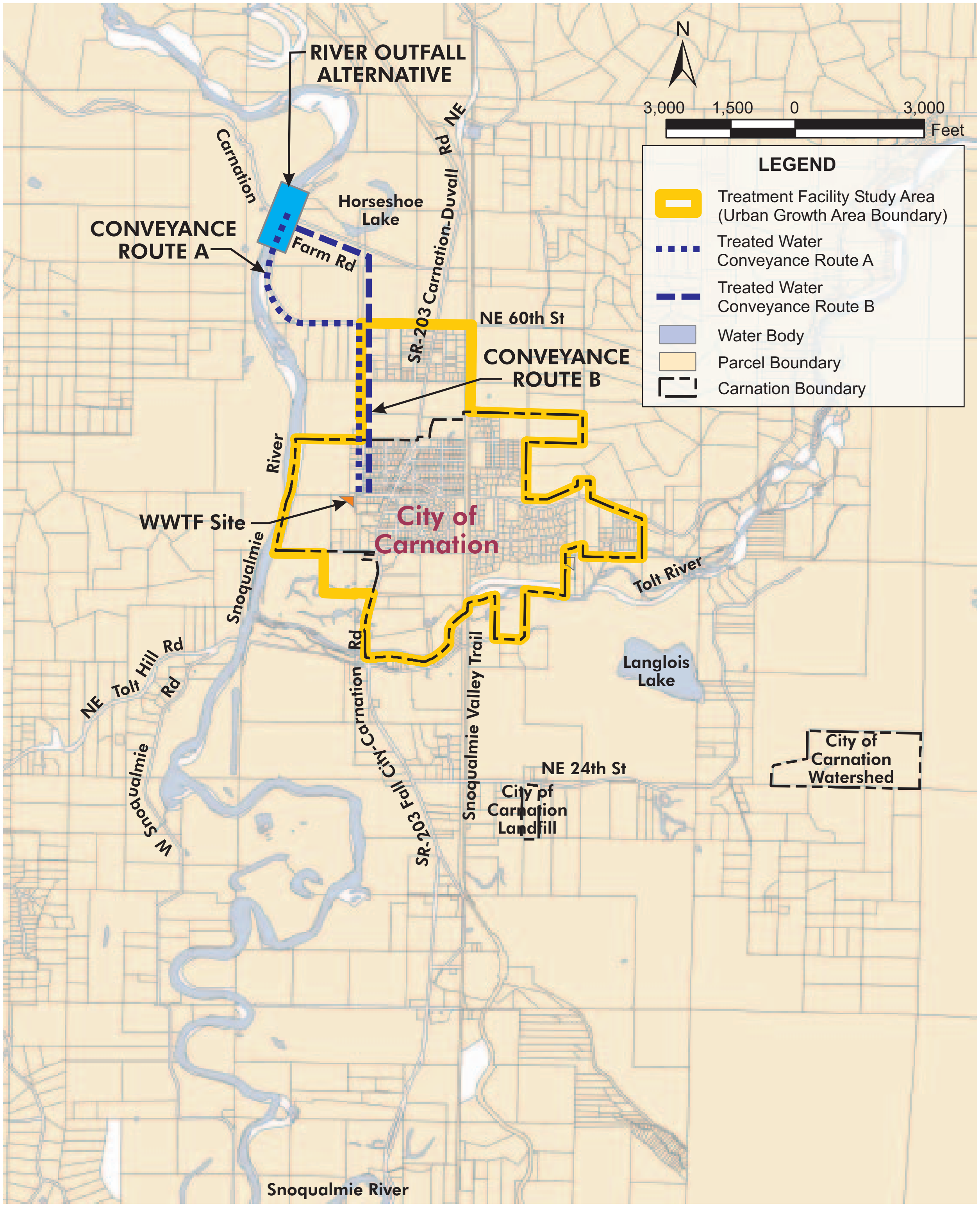


Figure 7.6
SNOQUALMIE RIVER OUTFALL CONVEYANCE COMPARISON
CARNATION WASTEWATER TREATMENT FACILITY
KING COUNTY DEPARTMENT OF
NATURAL RESOURCES AND PARKS

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Table 7.3 Conveyance Route Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

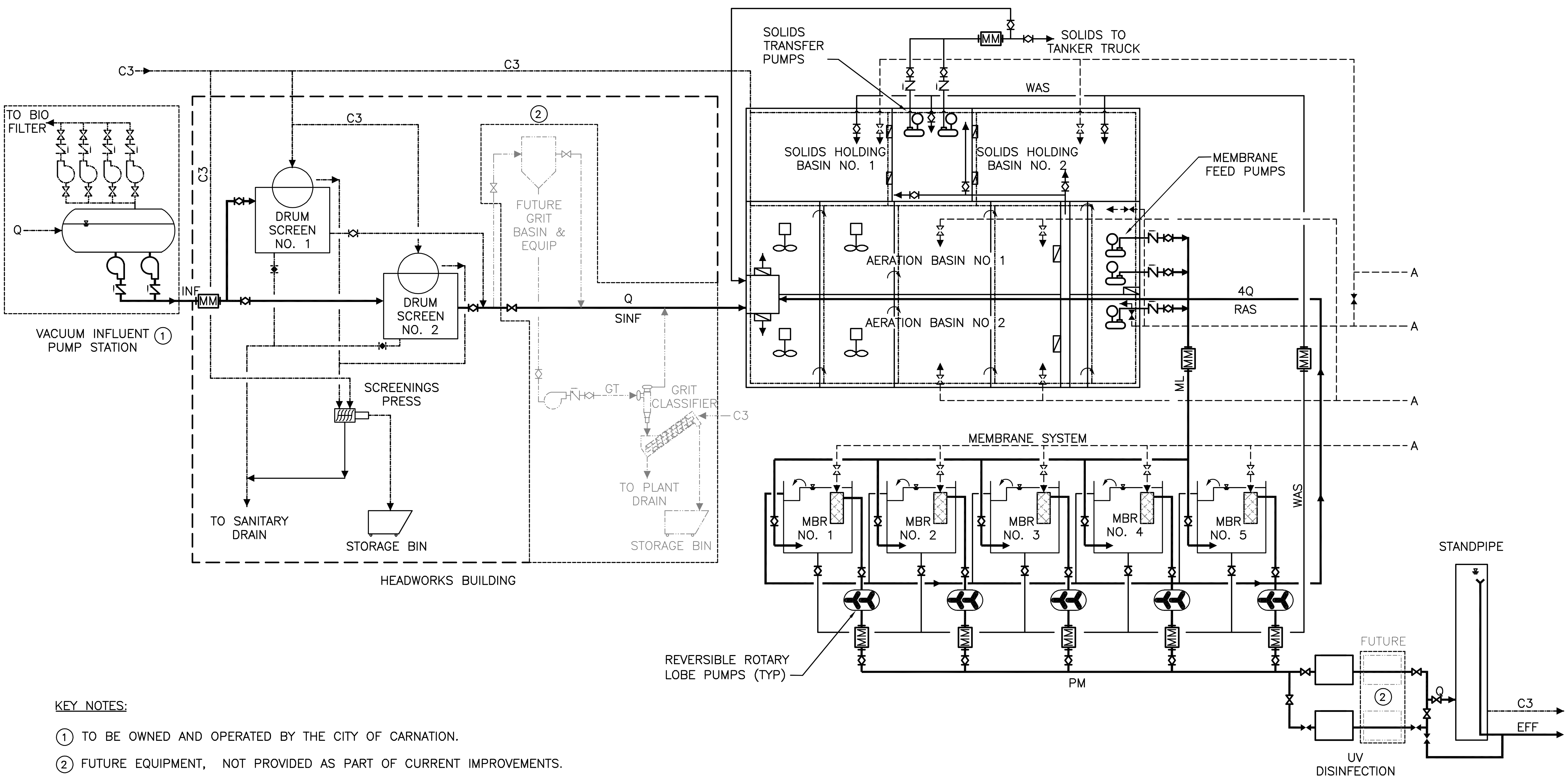
Parameter	Risk	Route A	Risk	Route B
Conveyance distance	**O**	Conveyance distance is 1.7 miles.	**O**	Conveyance distance is 1.6 miles.
Construction and easement costs (conveyance only)	**O**	Cost is approximately $1,100,000 without dewatering or wetland mitigation (in February 2005 dollars). Would require easement from one private entity.	**O**	Cost is approximately $1,000,000 without dewatering or wetland mitigation (in February 2005 dollars). Would require easement from two private entities.
O&M costs	**+**	Could potentially include increased costs. According to historical photos, flooding has submerged portions of 310th Avenue NE along the Snoqualmie River at least once within the past 20 years, severely damaging the roadway.	**-**	Will most likely require increased costs for wetlands mitigation.
Easement requirements	**+**	Easements will be required along the route between Bagwell Street and NE 60^{th} Street. The path has been designated a future City right-of-way.	**-**	Easements will be required along the route between Bagwell Street and Carnation Farm Road. The path between Bagwell Street and 310th Avenue NE has been designated a future City right-of-way.
Potential shoreline impacts	**O**	Increased risk of shoreline impacts along the River on 310th Avenue NE to the Bridge.	**O**	There is a potential shoreline impact at Bridge. In addition, the route would cross a small stream on Carnation Farm Road.
Wetlands impacts	**+**	No wetlands have been identified in the environmental review process.	**-**	Presence of jurisdictional wetlands on the property between NE 60th Street and Carnation Farm Road. Environmental review and mitigation would be required.
Constructability	**O**	Route is not anticipated to require dewatering. There is an increased potential need for dewatering along the river on 310th Avenue NE.	**O**	Dewatering may be required between NE 60^{th} Street and Carnation Farm Road near the jurisdictional wetlands.
Traffic and community disruption	**+**	Minimal impacts to residents expected within the immediate vicinity of pipeline construction.	**-**	Requires construction along 2,400-feet of Carnation Farm Road, one of two routes for crossing the river within the City's vicinity.

Table 7.3 Conveyance Route Comparison
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Risk	Route A	Risk	Route B
SEPA review	+	The environmental impacts of locating the outfall at the Bridge have been addressed in the final EIS.[282] There would be no impact on the current SEPA schedule.	-	The route change will likely require an addendum to the EIS.
Public opinion	+	Discussions of the route with adjacent property owners are underway. The SEPA public process requirements have been fulfilled.	-	Additional public outreach would be required due to the change in conveyance route. The redirection would require additional resources and potentially impact the project schedule. Based on a site visit by the County with the property owner and property tenant of the property between NE 60th Street and Carnation Farm Road on March 15, 2005, discussions have indicated that they do not support disturbing the soils or existing fencing. In addition, the railroad grade is used as a high ground shelter for farm animals during flooding events.

+ = more favorable
O = negligible difference in favorability
- = less favorable

SEPA = State Environmental Policy Act
EIS = Environmental Impact Statement



KEY NOTES:

(1) TO BE OWNED AND OPERATED BY THE CITY OF CARNATION.

(2) FUTURE EQUIPMENT, NOT PROVIDED AS PART OF CURRENT IMPROVEMENTS.

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED:

DRAWN:

RECOMMENDED:

APPROVED:

CHECKED:

NONE

SCALE:

CONTRACT NO: C______C

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS

CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.7

PRELIMINARY PROCESS SCHEMATIC

DATE: SEPT, 2005

FILE NO: 423557/###

DRAWING NO:

SHEET NO: OF

Table 7.4 Anticipated Discharge Requirements
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Allowable Limit
Year-Round or Non-TMDL Permit Limitations	
Average monthly	
BOD_5[a]	30 mg/L, 155 lb/day
TSS[a]	30 mg/L, 155 lb/day
NH_3-N[b]	38.3 mg/L
Fecal coliform[c]	50 cfu per 100 mL
Residual Cl_2[b]	0.063 mg/L
Average weekly	
BOD_5[a]	45 mg/L, 233 lb/day
TSS[a]	45 mg/L, 233 lb/day
NH_3-N[b]	91.3 mg/L
Fecal coliform	400 cfu per 100 mL
Residual Cl_2[b]	0.165 mg/L
Maximum daily	
Temperature (7-day average)[d]	16 ^oC
pH[e]	6.5 - 8.5
Turbidity[f]	5 ntu + river background
Total dissolved gas[g]	110 percent
Minimum daily	
DO[h]	9.5 mg/L
TMDL Permit Limitations (Aug - Oct)[i]	
Maximum daily	
BOD_5	25 lb/day
NH_3-N	8.4 lb/day
SRP	3 lb/day

BOD = biochemical oxygen demand
^oC - degrees Celsius
CFU = colony forming units
Cl_2 = chlorine
DO = dissolved oxygen
NH_3-N = ammonia-nitrogen
ntu = nephelometric turbidity unit
mg/L = milligrams per liter
mL = milliliter
SRP = soluble reactive phosphorus
TSS = total suspended solids
TKN = total Kjeldahl nitrogen

a. Average monthly concentration shall not exceed 30 mg/L or 15 percent of the respective monthly average influent concentrations, whichever is more stringent.
b. As reported by Cosmopolitan in TM No. 12 for these toxic substances. Table 4.2 of this document lists the other constituents such as metals, which are also regulated by the Surface Water Standards. Using updated potential dilution allowances; the allowable concentration would likely be greater than that reported in this document. See Chapter 4.1 for a discussion of the dilution factor.
c. Based on a geometric mean value, with not more than ten percent of all samples exceeding 100 colonies / 100 mL.
d. No temperature increase can raise the receiving water temperature by greater than 0.3^oC if natural temperature exceeds criteria.
e. Human-caused variation within acceptable range, less than 0.2 unit.
f. Results in less than a ten percent increase when the background turbidity is more than 50 ntu.
g. Criteria does not apply when the stream flow exceeds the seven-day, ten-year frequency flood (7Q10).
h. No DO decrease greater than 0.2 mg/L when the receiving water body is lower than the criteria due to natural conditions.
i. Based on the 1994 TMDL study for mass discharge loading. For the months of August, September, and October, the water quality must meet both the NPDES limits as well as the year-round limitations.

Sources: Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.; *Water quality standards for surface waters of the state of Washington*, *WAC 173-201A* (2003).; Joy, J., *Snoqualmie River Total Maximum Daily Load Study*, Ecology Report #94-71, 1994.

7.4.2 Influent

Forecasted design flows were developed as documented in the 2004 Comprehensive Sewer Plan[283] and TM No. 2[284] and are summarized in Table 7.5. Sizing was performed with Carollo's BioTran 2000™ program and the commercial program BioWin. Minimum flows for facility startup in 2007 represent the minimum condition for blower design. The maximum daily flows for the 2030 design flow condition represent the maximum conditions for compressor design. Design influent concentrations are presented in Table 7.6. It has been assumed that there is no removal of dissolved or suspended pollutants through preliminary treatment. Phosphorus concentrations are based on an analysis of wastewater characteristics within the BioTran 2000™ program.

Table 7.5 Influent Flow
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Influent Flow	Minimum startup flow (mgd)	Average startup flow (mgd)	Maximum month design flow (mgd)	Maximum day design flow (mgd)
Average base flow	0.18	0.22	0.53	0.86
Typical 4-hour diurnal peak	0.33	0.33	0.62	1.29
Peak hourly[a]	---	0.63	---	1.4

mgd = million gallons per day

a. Peak-hour facility capacity satisfied through increased MBR flux rates and MBR feed pump wet well equalization.

Table 7.6 Design Influent Concentrations Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks	
Parameter	**Concentration (mg/L)**
BOD_5	297
Filterable ("soluble") BOD_5	113
COD	683
TSS	297
NH_3-N	29
Organic-N	18
TKN	47
Total P	12
Alkalinity [a]	220
Temperature	
Summer	22^oC
Winter (design)	12^oC

BOD_5 = 5-day biochemical oxygen demand
C = degrees centigrade (or Celsius)
COD = chemical oxygen demand
TSS = total suspended solids
TKN = total Kjeldahl nitrogen
mg/L = milligrams per liter
N = nitrogen
NH_3-N = ammonia-nitrogen
P = phosphorus

a. Includes supplemental alkalinity addition.

Another key influent parameter assumption involves the design temperature. Certain biological processes, such as nitrification, are very sensitive to temperature. Discharge to wetlands would require the removal of ammonia to 1.5 mg/L and removal of phosphorus to 1.0 mg/L on a year-round basis. The sizing of biological tanks in TM No. 6 had been based on river discharge. River discharge requires ammonia and phosphorus removal during low river flow conditions. In TM No. 6,[285] design calculations assumed a temperature of 15 degrees Celsius. The minimum design temperature of 12 degrees Celsius has since been updated to satisfy both discharge methods. This results in a larger required basin volume than had been developed in TM No. 6.[286]

7.4.3 Headworks

The sewer flow from the community will be conveyed to a centralized wetwell (Vacuum Station No. 1) through a newly constructed vacuum-based sewer collection system. The headworks will consist of a two-story building, with screening and space for future grit removal on the upper level, and screenings handling and storage on the lower level. Upon further evaluation, it was proposed that as part of the recommended preliminary treatment, the raw sewage pass through two fine screens in parallel to remove inert material that can foul or abrade the membranes. The headworks design parameters are summarized in Table 7.7.

Table 7.7 Headworks Design
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Initial	Ultimate
Mechanical Screen		
Type	Perforated-plate rotary drum screen	Perforated-plate rotary drum screen
Number in service	1	1
Number on standby	1	1
Maximum capacity (mgd/each)	2.2	2.2
Mesh size (mm)	2	2
Screening Washer/Compactor		
Number in service	1	1
Grit Removal		
Type	NA	Induced vortex/cyclonic lamella
Number in service	NA	1
Number on standby	NA	Bypass
Hydraulic capacity (mgd)	NA	1.4
Pumping type	NA	Recessed impeller
Pumping capacity (gpm)	NA	300
Classifier type	NA	Cyclone/washer
Classifier capacity (gpm)	NA	305
gpm = gallons per minute mgd = million gallons per day mm = millimeter NA = not applicable		

The cost-effectiveness of installing a grit chamber at the CWWTF was further evaluated. Although the potential for additional abrasion to the mechanical equipment is increased, initial discussions with manufacturers and municipalities regarding vacuum-based sewer collection systems have indicated that only a minimal volume of grit will enter the system. Provisions will be made to permit the retrofitting of grit removal equipment in the future, as necessary.

7.4.4 Biological Treatment and Disinfection

Activated sludge with MBR technology was recommended for the CWWTF. The MBR technology provides the highest water quality while requiring the smallest environmental footprint. Biologically degradable dissolved, colloidal, and suspended organic material and nutrients will be removed with a modified BNR removal configuration (similar to the A^2O process) combined with separate MBR tanks as summarized in Table 7.8. The configuration will provide anoxic, anaerobic, and aerobic zones. The basins will be concrete tanks with outside wall heights of approximately 12 feet above grade and an overall water depth of 17 feet. If phosphorus is identified and/or regulated as problematic beyond the biological removal capabilities of the anaerobic zones, the facility can be retrofitted by adding a chemical precipitation system to the basins in the future.

Table 7.8 Treatment Design Criteria
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Minimum startup flow	Average startup flow	Maximum month design flow	Maximum day design flow
Biological Treatment Basins				
Overall Basin				
Number in service	1	1	2	2
Total number	2	2	2	2
Length, ft (inside)	60.0	60.0	60.0	60.0
Width, ft (inside)	14.0	14.0	14.0	14.0
Side water depth, ft	17.0	17.0	17.0	17.0
Volume, MG				
Zone 1 (anoxic)	0.017	0.017	0.034	0.034
Zone 2 (anaerobic)	0.017	0.017	0.034	0.034
Zone 3 (aerated)	0.029	0.029	0.059	0.059
Zone 4 (aerated)	0.043	0.043	0.087	0.087
Total volume	0.107	0.11	0.214	0.214
Theoretical HRT, hours	14.6	11.7	9.6	6.0
MLSS concentration, mg/L	8,500	8,500	8,500	8,500
Solids residence time, days	29.4	23.0	18.6	10.7
Recycle rate, %	500	500	500	500

Table 7.8	Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks			
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Aeration System				
Diffuser type	Membrane disc			
Air in aerated zones, scfm	110	130	320	620
Anoxic/Anaerobic Zone				
Number of mixers	2	2	4	4
Type	Horizontal submersible			
Waste Activated Sludge				
Waste sludge flow, lb/day	280	360	890	1,540
Concentration, mg/L	10,000	10,000	10,000	10,000
Aeration Blowers (Aeration and Solids-Handing Basins)				
Blower type	Positive displacement			
Number in service	2	2	2	3
Number on standby	1	1	1	0
Total number	3	3	3	3
Capacity required, scfm				
Aeration basins	115	135	390	740
Solids holding basins	95	165	165	250
Membrane feed pump wet well	30	30	30	30
Total capacity required	240	330	585	1,020
Blower capacity required, scfm (each)	340	340	340	340
Pressure differential, psig	10.2	10.2	10.2	10.2
HP (each)	25	25	25	25
Membranes				
Type	Hollow fiber or plate			
Total number of tanks	5	5	5	5
Average in service	3	3	4	4
Peak hour in service	5	5	5	5

Table 7.8 Treatment Design Criteria
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Minimum startup flow	Average startup flow	Maximum month design flow	Maximum day design flow
Maximum available capacity out of service during cleaning or maintenance (%)	25	25	25	25
Installed membrane area (per tank), sf	64,600	64,600	64,600	64,600
Minimum spares per tank (%)	25	25	25	25
Maximum allowable flux rate, gfd				
Average	14	14	14	14
Peak 4-hour diurnal peak	18.2	18.2	18.2	18.2
Peak hour	20	20	20	20
Operating flux rate, gfd				
Maximum monthly flow	4.2	5.2	6.3	10.2
4-hour diurnal peak flow	6.3	7.9	9.5	15.3
TMP, psi				
Average	2 - 5.8	2 - 5.8	2 - 5.8	2 - 5.8
Maximum	10	10	10	10
Approximate side water depth, ft	9	9	9	9
Minimum MLSS, mg/L	8,000	8,000	8,000	8,000
Maximum MLSS, mg/L	12,000	12,000	12,000	12,000
SOTE, %	6-8	6-8	6-8	6-8
Backpulse cycle				
Frequency (minutes between backpulse)	12	12	12	12
Duration (sec)	30	30	30	30
Flow rate (gpm)	179	179	179	179
Pressure (psig)	2 - 8	2 - 8	2 - 8	2 - 8

Table 7.8 Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Maintenance cleaning per tank				
No. of chlorine cleanings (per year)	90	90	90	90
Chlorine Conc. (mg/L)	250	250	250	250
Chlorine contact time (min/clean)	50	50	50	50
Recovery cleaning per tank				
No. of cleanings (per year per chemical)	2	2	2	2
Chlorine conc. (mg/L)	1000	1000	1000	1000
Chlorine contact time (hours/clean)	4-8	4-8	4-8	4-8
Citric acid conc. (mg/L)	2000	2000	2000	2000
Citric acid contact time (hours/clean)	4-8	4-8	4-8	4-8
Membrane Wet Well				
Number	1	1	1	1
Length, ft (each)	30	30	30	30
Width, ft (each)	10	10	10	10
Maximum depth, ft	17	17	17	17
Minimum depth, ft	4	4	4	4
Equalization volume, MG	0.029	0.029	0.029	0.029
Membrane Air / Agitation Air Blowers				
Blower type	Positive displacement			
Number in service	1	1	1	2
Number on standby	2	2	2	1
Total number	3	3	3	3

Table 7.8 Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Capacity required, scfm (each)				
Blower capacity, scfm (each)	725	725	725	725
Pressure differential, psig	4.2	4.2	4.2	4.2
HP (each)	30	30	30	30
Membrane Feed Pumps				
Pump type	Positive displacement			
Number in service	1	1	2	2
Number on standby	2	2	1	1
Total number	3	3	3	3
Capacity (each), gpm	2240	2240	2240	2240
TDH, ft	30	30	30	30
HP (each)	25	25	25	25
Membrane Permeate and Backpulse Pumps				
Pump type	Rotary Lobe			
Number in service	3	3	4	4
Number on standby	2	2	1	1
Total number	5	5	5	5
Permeate capacity (each), gpm	224	224	224	224
TDH, ft	55	55	55	55
Backpulse capacity (each), gpm	108 - 227	108 - 227	108 - 227	108 - 227
TDH, ft	25	25	25	25
HP (each)	10	10	10	10
UV Disinfection				
Type	high-output/medium-pressure in-vessel			
UV transmittance, %	65	65	65	65
Number of trains in service	1	1	1	1
Total number of trains	2	2	2	2

Table 7.8 Treatment Design Criteria Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Reactors per train	1	1	1	1
Effective dosage, MJ/sq CM	40	40	40	40
Outfall				
Type	Gravity flow from standpipe			
TDH, ft	28			

ft = feet
gfd = gallons of permeate produced per square foot of membrane per day
HRT = hydraulic retention time
MG = million gallons
mg/L = milligrams per liter
MJ/sq CM = millijoules per square centimeter
MLSS = mixed liquor suspended solids
lb/day = pounds per day
scfm = standard cubic feet per minute
sote = standard oxygen transfer efficiency
sf = square feet
UV = ultraviolet

The MBR pumping equipment and chemical feed equipment will be located in a concrete structure. The membrane tanks will be modular steel tanks that are mounted on the top of this structure. The MBR system will consist of cassette tanks, permeate pumps and backpulse system, blower system, electrical panels, and controls. Blowers for the MBR tanks and aeration basins/solids holding basins will be individually housed in sound enclosures at the southeast end of the MBR area.

The MBR process is considered to be the best available technology (BAT), consistently producing a high water quality that meets or exceeds the “Salmon and Trout Spawning, Core Rearing, and Migration for extraordinary primary contact recreation” surface water standards.[287] The CWWTF will achieve the nearly complete removal of BOD_5, TSS, and nitrogen, and will provide highly polished, high-quality water suitable for the potential unrestricted, cost-effective reuse of non-potable water in the future. The MBRs will be sized to handle peak capacities of 1.29 mgd over a four-hour peak flow period. The storage in the membrane feed pump wet well downstream of the aeration basins will provide the remaining instantaneous peak capacity for the facility from the City’s Vacuum Station No. 1 (1.4 mgd-1.29 mgd = 0.11 mgd), prior to the MBR process.

Membranes in the MBR process provide a physical barrier to remove solids and bacteria, making it the most reliable treatment process capable of filtering water to a final turbidity less than 0.2 ntu. Disinfection will be provided by a closed channel UV disinfection system that is capable of being retrofit to meet the Class A reclaimed water standards.[288] UV disinfection technology has the lowest space requirement and is the most suitable for the design flexibility of the CWWTF. Should the County choose to provide reclaimed water in the future, the UV dosage design will comply with the reuse standards in effect at the time a reclaimed water permit is requested.

7.4.5 Solids Handling

The collected screenings and grit will be cleaned and dewatered as accumulated to minimize the odor production potential of the residuals. After cleaning and dewatering, the screenings and grit chamber residuals will be transported directly to a local landfill for final disposal.

It is recommended that the wasted solids from the MBR be held at the CWWTF and transported to a regional County treatment facility such as the South Treatment Facility or possibly the Brightwater facility in the future. The additional waste activated sludge is not anticipated to adversely impact the existing process at either the South Treatment Facility or the future Brightwater facility. The solids will be gravity-thickened while held onsite for an average of seven days in covered and aerated solids holding basins, as summarized in Table 7.9. The aerated solids holding basins will also provide emergency storage and limited stabilization. The facility could be designed with the flexibility to use an MBR tank to produce a higher solids concentration in the future, as needed, to reduce the volume of solids transported as the facility approaches design loads.

Table 7.9 Solids Holding Basins
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Minimum startup flow	Average startup flow	Maximum month design flow	Maximum day design flow
Number of units	2	2	2	2
Length, ft	30.0	30.0	30.0	30.0
Width, ft	14.0	14.0	14.0	14.0
Depth, ft				
Maximum	17.0	17.0	17.0	17.0
Minimum	3.0	3.0	3.0	3.0
Total volume, gal				
Maximum	106,800	106,800	106,800	106,800
Storage	88,000	88,000	88,000	88,000
Minimum tank solids concentration with decant, %	1.0	1.0	1.0	1.0
Storage time with decant, days	25	19	8	4
Predicted volatile solids reduction, %	15	22	20	25

Table 7.9 Solids Holding Basins Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Parameter	**Minimum startup flow**	**Average startup flow**	**Maximum month design flow**	**Maximum day design flow**
Predicted sludge production (WAS), gpd	3,500	4,500	11,300	20,300
Aeration System				
Type of diffuser	Fine	Fine	Fine	Fine
Aeration required, scfm				
For volatile solids destruction	27	50	115	249
For mixing	89	163	163	163
Controlling	89	163	163	249
ft = feet gal = gallons gpd = gallons per day scfm = standard cubic feet per minute WAS = waste activated sludge				

7.4.6 Odor Control

Since as the City-owned site is both directly upwind of and lower in elevation than the majority of City structures, it is critical that the odor control system design must be both sensitive to the community's needs and cost-effective. As a result, the design philosophy for the CWWTF is to incorporate conservative provisions to fully contain and treat nuisance odors that result from those treatment processes with the highest potential of producing detectable odors.[289]

It is recommended that treatment be provided using fiberglass or aluminum covers over identified process areas and connected to a single-stage activated-carbon-scrubbing unit. Both basin covers and separate building enclosures were considered for this project. Basin covers were chosen as the preferred containment method as they can be placed directly over the basins to provide for a more compact and less expensive installation. Preliminary estimates for the basin covers were between $25 and $50 per square foot. A typical estimate for a building to enclose the basins is approximately $150 per square foot and requires a much larger footprint. The volume of air to be treated with the covered basin option is also significantly less, which also affects the capital and operating costs.

Due to the relatively small air flow volumes associated with each process and the close proximity of the processes, a central system is recommended. The unit would remove hydrogen sulfides as well as other VOCs from the headworks, anaerobic and anoxic zones, membrane feed pump wet well, and solids-handling emission stream areas. Conservatively designed with an 8,000-scfm capacity, the scrubber could sufficiently provide full odor removal capacity during peak events. It is not anticipated that a second-stage or redundant system will be necessary to further protect the surrounding community from nuisance odors. During times when the scrubber is scheduled for maintenance, the County's transportable carbon scrubbers can be mobilized and connected to the ductwork to provide additional treatment.

7.4.7 Support Facilities

The operations building will include an office, conference/lunch room, laboratory, restroom, shop, and electrical room. The electrical room will house motor control centers (MCCs), variable-frequency drives (VFDs), and other electrical equipment. The shop will include a workbench and basic tools for plant maintenance. The chemical feed building will be located at the south end of the MBR building.

7.4.7.1 Laboratory

Employees will conduct limited testing on samples and generate reports in the laboratory. Typically, an oven, refrigerator, sinks, glassware storage, glassware washer, and ample counter space are needed. Cabinetry for glassware storage and a small fume hood will be provided. Limited quantities of point-of-use chemicals will be stored in a ventilated cabinet below. A small workstation, accessible to disabled employees, will provide space for a computer and printer. This laboratory will be similar in size and function to the laboratory currently being constructed for the Vashon Island Wastewater Treatment Plant.

7.4.7.2 Control, Break, and Office Room

The facility control area, break area, and office area will be separated into distinct areas but combined within a single room to facilitate access by a single supervisor. The room will be situated to have visual access to the parking area and entrance gate. Staff working in the control area will need ready access to the restrooms. The control area will have space for a single workstation, including Network access, telephone, closed circuit TV (security), operations manuals, and filing access. This area will be used to monitor plant operations. The break area provides a place for employees to eat meals and gather for meetings. A kitchenette with a refrigerator and microwave will be provided. The office area will require storage for files and manuals and will include a work desk with a separate computer and an office chair. This space should also have network access and phone lines. A centralized space for a copy machine, printer, and plan layout area will be provided.

7.4.7.3 Electrical Room

The electrical room in the operations building will support the entire facility. Based on an initial evaluation, the total connected electrical load for the proposed facility is approximated to be 500 kilovolt-amperes (kVA). The load includes an additional estimated 100 kVA for building services, including lighting and heating, ventilation, and air conditioning (HVAC) systems. This load can be accommodated by a 600-amp service at 480 volts AC, 3-phase, 60-hertz (Hz) from the local utility, with provisions included in the design for increasing service to 1200-amps in the future. The County and the City are coordinating their discussions on the electrical capacity requirements for both facilities from the local power utility.

Puget Sound Energy (PSE) is the local utility that provides electricity and natural gas service within the City. For service to a wastewater treatment facility, utilities normally furnish and install a padmounted transformer near the location of service. Initial discussions with PSE have indicated that 3-phase power is available at the corner of Highway 203 and Entwistle Street for the City-owned site. PSE may have additional installation requirements to establish the required power at the City-owned site. Additional details are provided in TM No. 10[290] or will be confirmed as design development progresses.

7.4.7.4 Restrooms/Showers

Restrooms and locker facilities are essential to the safety and welfare of employees. During facility operations, it is not uncommon for employees and uniforms to get dirty so showers and lockers for clean and soiled garments will be provided. For facilities between one and ten employees, the code allows for the installation of a single unisex restroom. The design of the single unisex restroom will provide some separation between the area provided specifically for employees and the areas of general use.

7.4.7.5 Chemical Feed

The CWWTF will potentially use liquid sodium hypochlorite for cleaning and periodic odor control. Sodium hypochlorite and citric acid will be required for routine maintenance cleaning and periodic recovery cleaning of the MBR and UV systems. Magnesium or sodium hydroxide will be added to satisfy the nitrification alkalinity requirement as well provide pH adjustments. Chemical feed requirements will be further developed during the design phase.

The chemical area will house chemicals needed for equipment cleaning (sodium hypochlorite and citric acid) and alkalinity adjustment (magnesium or sodium hydroxide). Citric acid will be stored in a tote while the hypochlorite and hydroxide will be stored in chemical tanks. The chemical area will also include future space for aluminum sulfate (alum) or ferric chloride should chemical precipitation be required in the future.

7.4.7.6 Workshop

An overhead-coiling door will be provided to access the workshop, which will include a workbench and work area. Large repair jobs will most likely be done offsite. A workbench and a lockable tool closet are necessary for security.

7.4.7.7 Standby Generator

The critical nature of the CWWTF is such that it will require continuous operation. Standby power must be provided for the entire facility so that the process may continue operation in the event of a loss of power from the utility. By using techniques such as load sequencing and solid-state “soft” starters for motors larger than 25 horsepower (hp), the size of the standby generator can be kept to a minimum. Preliminary calculations indicate that a standby generator rated at approximately 700 kilowatts (kW) would be sufficient.

The standby generator will be a self-contained, enclosed package unit furnished with separately mounted fuel tank(s) above grade. The fuel tank(s) will be sized to supply a minimum of 48 hours of power to the facility in the event of a power loss. There will be a transfer scheme between the main breaker and the generator breaker to transfer power supplied to the switchgear main bus from the utility to the generator whenever there is a loss of utility power and transfer power back to the utility after power is restored.

7.4.7.8 Fire Detection

At a minimum, the facility will include a fire detection system. Fire detection and monitoring will be provided for each building. The status of the fire detection system will be transmitted through the plant supervisory control and data acquisition (SCADA) system.

7.4.7.9 Security System

The facility will include a security system. At a minimum, entrance through the main gate will be controlled and monitored by a card reader system that transmits information through the facility’s SCADA system. The security system will also be monitored remotely at another regional County facility during hours without facility staff. Whether access to other buildings should be monitored and controlled will be investigated and determined during the initial design stage.

7.4.8 Staffing Requirements

It is anticipated that the facility will be staffed with the equivalent of a single full-time employee (FTE). Additional maintenance needs will be scheduled and serviced through the County’s available resources on an as-needed basis. This is based on a 50 percent time allotment for operations duties and 50 percent time allotment for maintenance responsibilities.

7.5 Hydraulic Analysis

The hydraulic profile for maximum, average, and minimum flows at the CWWTF is presented in Figure 7.8. Pipe diameters and gate sizes for the headworks were sized by maintaining a minimum velocity of 2.7 feet per second (fps) and a maximum velocity of 3.9 fps. The ultimate peak flow to the headworks was assumed to be 1.4 mgd as indicated in the 2004 Sewer Facilities Plan.[291] Pipe sizes for process areas downstream of the headworks were sized to maintain minimum velocities of 0.5 fps and maximum velocities of 8.0 fps. Solids settling in the pipes are not anticipated to be a problem downstream of the MBR process because of: 1) the high water quality, and 2) flushing events to re-suspend any solids that may settle in the return activated sludge (RAS) line.

The resulting profiles indicate that a hydraulic head of 13.6 feet above the ground surface is required at the headworks to drive the treatment process to the aeration basin mixed liquor suspended solids (MLSS) wet well and accommodate the needed equipment in the headworks. MLSS is pumped from the aeration basin wet well to the MBR process. RAS flows by gravity back to the aeration basin flow splitter structure, and permeate is pumped through in-vessel UV disinfection to the effluent standpipe. The highly treated water can either be used for non-potable plant processes within the facility or overflows to a discharge pipe and is sent to the river outfall. Additional assumptions are detailed in TM No. 4.[292]

The standpipe water surface was set at 25 feet above the existing ground surface as a preliminary boundary condition for the hydraulic analysis. The height of the standpipe water surface elevation will be refined as the exact outfall location is established. Preliminary headloss calculations have indicated that the 25 feet of hydraulic head will sufficiently allow the highly treated water to be discharged by gravity. Design will proceed with a 33-foot high tank. Calculations, provided as Appendix H, assume the use of 12-inch HDPE pipe from the standpipe to the east edge of the Bridge. The pipe will be reduced to an 8-inch ductile iron (DI) pipe and supported off the bridge to the discharge location point. The highly treated water will be discharged through a diffuser check valve.

The flexibility of the standpipe design will allow a small booster pump to be installed to increase the available total dynamic head should another discharge alternative be selected in the future. For example, preliminary headloss calculations have indicated that discharging to the SWA will require over 30 feet of hydraulic head. Calculations, provided as Appendix H, assume the use of 12-inch HDPE pipe from the standpipe to the general SWA. The calculations do not account for a wetlands discharge design and should be updated if the alternative is chosen in the future.

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H:\Client\KingCo-DNR_SEA\6620a10\Dn\Dwg\FIGURE_7-8 9-23-05 09:59am JCheesebro XREFS: D-TTL-KC-CARN; x6620-G-00-101

GENERAL NOTES:

1. VERTICAL ELEVATIONS ARE BASED ON NAVD 88 DATUM.
2. 100-YEAR FLOOD 74.11; 500-YEAR FLOOD 75.60 } (DRAFT FEMA MAP, JUNE 2005)

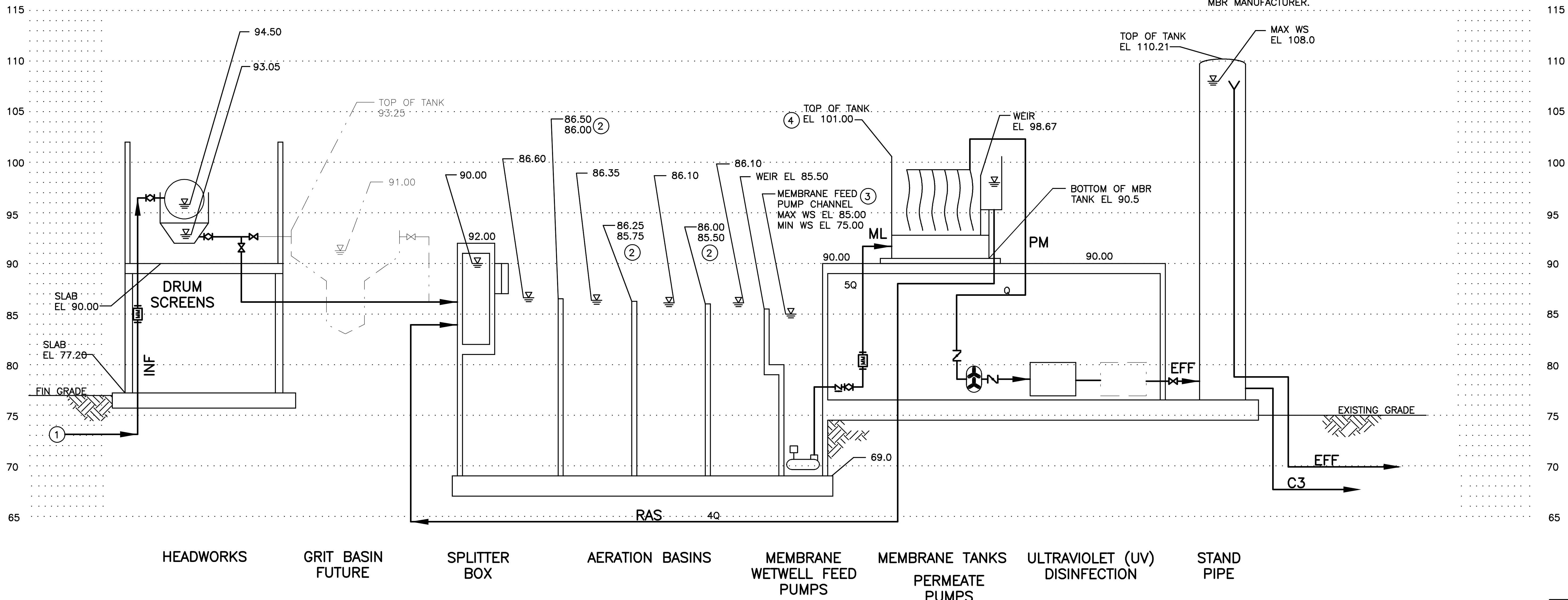
KEY NOTES:

(1) HEADWORKS FLOWS FROM CONSTANT SPEED PUMP STATION (BY OTHERS) WITH 1.4 MGD CAPACITY. FLOW IS INTERMITTENT.

(2) TOP OF BAFFLE WALL AND TOP OF NOTCHED END OF WALL.

(3) Q = 1.4 MGD PRIOR TO MBR FEED PUMPS.
Q = 1.29 MGD DOWNSTREAM OF MBR FEED PUMPS.

(4) ELEVATION ASSUMES 2 FEET OF FREEBOARD. TANK TO BE PROVIDED BY MBR MANUFACTURER.



HYDRAULIC PROFILE

HORIZONTAL SCALE: NOT TO SCALE
VERTICAL SCALE: 1" = 10'-0"

LEGEND

W.S. ELEVATION AT PEAK CAPACITY

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

carollo engineers

DESIGNED: SEF	CHECKED: NONE
DRAWN: KWH	SCALE:
RECOMMENDED:	CONTRACT NO: E23020E
APPROVED:	

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
CARNATION WASTEWATER TREATMENT FACILITY

FIGURE 7.8

HYDRAULIC PROFILE

DATE: SEPT, 2005
FILE NO: 423557/###
DRAWING NO:
SHEET NO: OF

7.6 Conservation by Water Demand Management

It is the County's desire to reduce wastewater production rates in all of its service districts. The City details their water conservation policy in the 2004 Comprehensive Sewer Plan.[293] Furthermore, 90.48.495 RCW requires that sewer plans include an analysis of the potential effects of water conservation programs on wastewater flow. Although the CWWTF will be a new facility, existing housing and commercial establishments in the City will include a variety of older, conventional fixtures. It is possible that replacement of conventional fixtures with water-conserving fixtures could result in a further reduction of unit wastewater flow rates. This would not be expected to affect wastewater pollutant loads, except that concentrations would be increased.

Numerous water demand management studies have shown that significant reductions can be made in response to conservation measures.[294,295,296,297] In accordance with the Countywide Planning Policies presented in King County Comprehensive Plan[298] and to satisfy the requirements of 90.48.495 RCW, a review and cost analysis were commissioned by the County in 2004 to determine the cost implications of employing a water demand management program (retrofits and/or new plumbing codes) in conjunction with the design of the CWWTF. Two independent consultants were chosen to prepare the analysis due to their extensive experience and expertise in water efficiency pilot programs and studies. The financial implications were analyzed in two parts: 1) evaluate the feasibility of using demand management measures to reduce flows to the proposed CWWTF, and 2) evaluate the cost implications of reducing indoor water usage in existing and future homes and businesses within the City.

Impacts of different levels of conservation measures on flow reductions were compared to the current engineering design. Based on the range of resulting flows, four alternatives were selected for cost evaluation.

- **Current Design** – uses the per capita rates derived from historical water usage and agreed upon between the County and the City. The rates do not account for future per capita demand reductions.

- **Code Compliance** – assumes water usage remains similar to historical patterns but accounts for both natural replacement and the fact that new development will meet current plumbing codes (1992 Uniform Plumbing Code) and install "average" efficient fixtures.

- **Best Available Technology (BAT) New Construction** – assumes water usage remains similar to historical patterns but accounts for: 1) natural replacement rate of uprgrade to efficient fixtures, and 2) enhanced water efficiency building standards will require all new development to install BAT fixtures.

- **Mandatory BAT (all)** – assumes all existing fixtures and appliances will be retrofitted with BAT, and 2) enhanced water efficiency building standards will require all new development to install BAT fixtures.

Table 7.10 presents the assumed unit rates for wastewater flow production for each of the four water demand scenarios. Table 7.11 presents the resulting water demand impacts of conservation over the design life of the CWWTF.

Table 7.10 Unit Water Consumption Rates for Water Conservation Scenarios
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Parameter	Current Design	Code Compliance	BAT New Construction	Mandatory BAT
Residential (gpcd)[a]	65/NA/65	60/48/47	60/48/32	32/NA/32
Commercial (gpcd)[b]	30/30	24/20.4	24/18	18/18
Agricultural (gal/account/day)[b]	100/100	210/210	210/147	210/147
Elementary school (gal/student/day)[b]	10/10	2.7/2.7	2.7/2.2	2.2
Middle school (gal/student/day)[b]	16/16	2.7/2.7	2.7/2.2	2.2
High school (gal/student/day)[b]	NA/10	NA/3.3	NA/3.0	NA/3.0
Unclassified accounts (gal/account/day)[b]	NA/NA	419/NA	419/NA	293/NA
Unmetered/ unaccounted use (%)[b]	NA/NA	6/NA	6/NA	4/NA
Remlinger Farms (gpd)[b]	7661/NA	7661/NA	7661/NA	5363/NA

gal = gallons

gpcd = gallons per capita per day

gpd = gallons per day

NA = not applicable

a. Existing establishment / retrofitted establishment / new development

b. Existing establishment / new development

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

Table 7.11	Projected Average Annual Flow Rates for Water Conservation Scenarios Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks			
	Average Annual Flow Rate (mgd)			
Year	**Current Design**	**Code Compliance**	**BAT New Construction**	**Mandatory BAT**
2007	0.21	0.21	0.15	0.12
2012	0.32	0.27	0.22	0.18
2022	0.35	0.29	0.24	0.20
2030	0.37	0.30	0.25	0.21

mgd = million gallons per day

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

The conservation study concluded that by accounting for current plumbing codes and natural replacement rates for household appliances, the flow to the CWWTF could potentially be reduced by almost 20 percent at design year. Conservation by stricter mandated plumbing codes may result in a 27 to 30 percent reduction of flow. Mandated conservation (retrofits and new construction plumbing codes) is estimated to provide a 32 to 43 percent flow reduction at design year.

The demand reductions determined within the study were comparable to those experienced through conservation and retrofit projects undertaken by other municipalities. Heatherwood, Colorado, studied a scientifically selected sample of residential water customers to determine baseline conservation data and behavioral changes.[299] Although toilet flushing and shower duration increased after conservation measures were implemented, neither was found to be statistically significant at the 90 percent confidence interval. Based on a three-year study that evaluated water use in 1,188 study homes across 12 cities in the United States and Canada, the average daily per capita use was found to be 69.3 gallons.[300] After the national study, Seattle,[301] East Bay Municipal Utility District (EBMUD),[302] and Tampa[303] participated in follow-up studies to provide further insight into the savings that could be achieved from the installation of high-efficiency toilets, clothes washers, showerheads, and faucets. Table 7.12 presents the conservation retrofit study findings.

Table 7.12 Conservation Retrofit Project Study Findings Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Year	**Location**	**No. of Homes in Study**	**Baseline Water Usage (gpcd)**	**Retrofit Water Usage (gpcd)**
2004[a]	Carnation	733	60.0	31.6
1995[b]	Heatherwood	14	58.8	46.1
2000[b]	Seattle	37	63.6	39.9
2003[b]	EBMUD	33	86.2	52.6
2004[b]	Tampa	26	77.2	38.5

gpcd = gallons per capita per day

EBMUD = East Bay Municipal Utility District

a. Projected values. Assumes the Mandatory BAT conservation alternative.

b. Measured.

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

To explore the financial impacts of conservation, a study[304] was completed to provide a cost overview of the three conservation scenarios. The Current Design alternative was not analyzed for financial impacts. Costs were developed for the implementation of conservation programs, total project and operation costs of the new collection and treatment facilities, and energy savings. Program costs for Mandatory BAT included: 1) full retrofits for homes and businesses, 2) residential toilet flapper replacement program and public information budget, 3) non-residential audit/leak repairs and air-cooled equipment rebate program, and 4) County start-up program staff. Implementation costs for BAT New Construction are based on the Mandatory BAT program but do not include a retrofit program and only support conservation maintenance for new structures. Flow-dependent impacts and costs were identified for the sewer system, CWWTF, and potable water system. The findings are based in significant measure on the capital and O&M cost inputs for the collection system and CWWTF. A sensitivity analysis indicated that other selected input assumptions have no significant effect on the cost-effectiveness comparison to the Current Design. No program costs were assumed for the Current Design and Code Compliance scenarios.

The cost analysis also evaluated the cost-effectiveness from separate cost allocation perspectives. Costs allocated to the County included conservation implementation, capital, and O&M costs for the CWWTF. Costs allocated to the City included 1) the capital and O&M costs for the sewer collection system, and 2) energy cost savings and reduced chlorine usage in potable water distribution. Costs credited to the customer included avoided energy costs. Table 7.13 compares the net present value of combined and individual perspective costs for each alternative in 2004 dollars for the design life of the facility (2007 to 2030), with an assumed annual cost of capital of 5.25 percent and an inflation rate of 2.25 percent per year. The combined perspective accounts for the sum of all the flow-dependent costs for the County, City, and customer.

Table 7.13 Cost Impacts of Conservation Alternatives
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Alternative	Net Present Value ($ in millions)			
	Combined	County	City	Customer[a]
Code Compliance	31.00	15.07	15.93	0.0
BAT New Construction	30.74	15.10	15.80	-0.15[b]
Mandatory BAT (all)	30.65	15.92	15.67	-0.94

a. A negative cost is a benefit.

b. Customer benefits accrue only for owners of new structures.

Source: Carollo Engineers, *Review and Cost Analysis of Demand Reduction Project for Carnation Treatment Plant, DRAFT*, December 2004.

The economic analysis showed that the distribution of costs may require a higher initial cost by as much as $850,000, to implement the conservation program upfront.[305] Aggressive conservation is unlikely to cost more than a design approach (which does not account for conservation) over the entire design life of the facility. A 25 percent wastewater flow reduction corresponds to a two percent reduction of wastewater facility costs.

Conservation-based demand reductions only affect flow-dependent unit processes, which result in material reductions. That is, capital and O&M costs for the sewer collection system and CWWTF are only reduced if the flow savings causes a decrease in equipment rating or material usage. Due to the relatively small flow to the CWWTF, some equipment and support facilities are negligibly impacted because the current design already reflects the smallest-capacity range. Other aspects of the facility are either size-constrained by the pollutant load (not reduced on a lb/day basis) or serve on a support basis independent of the flows.

The conservation scenarios evaluated represent an initial estimate of the impacts of conservation. Both the City and the County have an obligation to maximize the overall environmental and intangible benefits in a cost-conscious manner. The County will discuss possible financially sound conservation programs with the City. Conservation practices will have little to no effect on the design of the CWWTF or the collection system but may impact the associated O&M costs.

7.7 Reliability and Redundancy

For the river outfall discharge alternative, the CWWTF is required to meet a minimum Class II level of reliability and redundancy. Reliability Class II is for "works whose discharge, or potential discharge, as a result of its volume and/or character, would not permanently or unacceptably damage or affect the receiving waters or public health during periods of short-term operations interruptions, but could be damaging if continued interruption of normal operations were to occur."[306] The County has committed to designing the CWWTF to have the flexibility to meet the strict *Washington Reclamation and Reuse Standards*[307] reliability and redundancy standards in the future. Reclamation facility standards are also generally more stringent than tertiary treatment standards for disinfection, reliability, and solids removal and are summarized in Table 7.14 as they apply to the CWWTF design.

Table 7.14 EPA Unit Process Component Reliability Requirements
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Component Installed	Class II Reliability Standard	Reclamation Standard
Mechanically cleaned bar screens	Backup unit required (may be manual).	Backup unit required.
Pumps	Backup unit provided for each set of pumps.	Backup unit provided for each set of pumps.
Aeration basin	At least two equal volumes must be provided.	Multiple units capable of providing oxidized wastewater with one unit out of service.
Aeration blowers or aerators	Provide capacity sufficient to meet peak oxygen demand with largest unit out of service.	Multiple units capable of providing oxidized wastewater with one unit out of service.
UV disinfection system	No requirement listed. Common design practice is to provide redundant capacity.	Standby unit / equipment required.
Emergency effluent storage	No requirement.	24-hour maximum daily flow or alternative disposal method.

Sources: Washington State Department of Ecology, *Criteria for Sewage Works Design*, 1998. G2-64.
Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.

In the State of Washington, reclaimed water is categorized into four classes of water quality. The classification dictates their approved usages. Class A is classified as the highest quality of reclaimed water, requiring the wastewater to be oxidized, coagulated, filtered, and disinfected. Classes B, C, and D require varying levels of oxidation and disinfection. Unrestricted urban reuse or beneficial use to wetlands such as the SWA would require the water to meet Class A standards.

In general, the facility will be designed to provide constant, reliable treatment; have on-line automated alarms; and possess redundancy or standby equipment for each unit treatment process. Mechanical treatment devices such as screens, pumps, and blowers are provided with one unit as standby. The facility processes will be designed to continue to fully treat the flow while any single process unit is removed from service for maintenance or repair. A more detailed explanation of the redundancy cost basis is given in TM No. 6.[308]

In the event that the County or the City would be interested in beneficial reuse in the future (wetlands restoration or urban use), the CWWTF design has the flexibility to meet the Class A reclaimed water standards and the reclaimed water standards for discharging to wetlands.[309] Ecology would require an engineering report that contains a description of the design of the proposed reclamation system and the means of achieving compliance with the standards. Appendix I provides a reliability checklist and water quality compliance comparison for the facility. The appendix is designed to provide an indication of the general facility design requirements as set forth by the reclamation standards[310] in terms of reliability and water quality. The appendix is not intended to provide an all-inclusive list of criteria that must be met to use reclaimed water. For example, discharge to beneficial use wetlands requires background studies, the performance of periodic biological monitoring, a demonstration of a net environmental benefit, compliance with the allowable hydraulic loadings, and area impairment analysis for the Snoqualmie River. Areas containing or using reclaimed water must notify all persons who would have probable reason to make use of the area. Pipelines containing reclaimed water must be purple, clearly labeled, and located so that no cross-contamination with potable lines may occur. All valves, storage facilities, and outlets should be tagged or labeled that the water is not intended for potable purposes. Permitting, distribution design and monitoring requirements will be reviewed if the highly treated water will be used for reclamation purposes in the future.

7.8 Final Planning Cost Estimate

The costs for the CWWTF were revisited to provide an updated estimate of the total project costs. Treatment facility estimated quantities and costs were updated based on the preliminary site plan layout identified in Figure 7.1. Conveyance and discharge costs are based on the recommended discharge conveyance route as illustrated in Figure 7.2 and assume the discharge pipeline is supported on the Bridge to the west pier. Table 7.15 summarizes the total project cost of the CWWTF, conveyance, and discharge to the Snoqualmie River. The discharge route proceeds north to NE 60th Street and heads northwest to the Bridge along 310th Avenue NE. Appendix J provides the detailed estimates used to develop unit prices for installed pipe for each of the routes discussed in this chapter. Appendix K provides the updated estimate comparison of the project if the highly treated water was discharged to the SWA for beneficial use. Table 7.15 does not include any potential costs associated with purchase or lease of land for the CWWTF. The City and County will be involved in discussions to come to an agreement for long-term use of the CWWTF site area. The County currently estimates a purchase price of approximately $200,000 for as much as two acres of the property.

Table 7.15 Conceptual Level Cost Estimate
Carnation Wastewater Treatment Facility
King County Department of Natural Resources and Parks

Description	Quantity of units	Unit	Unit Price ($/unit)	Installation Price ($)	Total Price ($)
Wastewater Treatment Facility					
Capital costs					
Mobilization	1	LS	500,000		500,000
Sitework[a]					
Excavation	4,200	CY	30		126,000
Backfill	2,100	CY	30		63,000
Yard piping	1	LS	150,000		150,000
Paving	20,400	SF	4		81,600
Miscellaneous utilities	1	LS	200,000		200,000
Landscaping	1	LS	100,000		100,000
Fencing	1,000	LF	15		15,000
Lab/admin building					
Concrete masonry unit (CMU) structure	3,500	SF	150		525,000
Lab equipment	1	LS	100,000		100,000
Finish lab/admin area	1,500	SF	50		75,000
Chemical storage	1	LS	100,000		100,000
HVAC	1	LS	100,000		100,000
Headworks/treatment basins					
Base slab concrete	260	CY	250		65,000
Wall concrete	530	CY	750		397,500
Elevated concrete	60	CY	500		30,000
Headworks building	1,900	SF	100		190,000
Screening equipment	1	LS	250,000	30,000	280,000
Aeration system	1	LS	150,000	50,000	200,000
Solids-handling/wet well covers	1	LS	100,000		100,000
Odor control scrubber/ductwork	1	LS	500,000		500,000

Table 7.15 Conceptual Level Cost Estimate Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks					
Description	**Quantity of units**	**Unit**	**Unit Price ($/unit)**	**Installation Price ($)**	**Total Price ($)**
MBR/UV area					
Base slab concrete	140	CY	250		65,000
Wall concrete	50	CY	750		37,500
Metal roof structure over MBR area	2,450	SF	30		73,500
MBR treatment equipment	1	LS	900,000	300,000	1,200,000
UV disinfection equipment	1	LS	500,000	50,000	550,000
Standpipe equipment	1	LS	100,000		100,000
Electrical and controls (15% of total)	1	LS	888,600		888,600
Estimating contingency	10	%		+	681,300
Capital costs subtotal					7,494,000
Contractor overhead and profit	15	%			1,124,100
Sales tax	8.8	%		+	758,400
Direct construction cost subtotal					**9,377,000**
Allied costs					
Consultant services					
30% design					827,000
Final design					990,000
CM support services	4	%			375,000
KC admin and other allied costs				+	900,000
Allied costs subtotal					**3,092,000**
Total CWWTF Project Costs (Feb 2005)					**12,469,000**
Conveyance and Discharge to River at the Carnation Farm Road Bridge					
Capital costs					
Conveyance					
12' HDPE - CWWTF to Bagwell St.[b]	1500	LF	95		143,000
12" HDPE - Bagwell St. to NE 60th[c]	2700	LF	62		168,000
12" HDPE - NE 60th to Bridge[b]	4600	LF	95		437,000

Table 7.15	Conceptual Level Cost Estimate Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks				
Description	**Quantity of units**	**Unit**	**Unit Price ($/unit)**	**Installation Price ($)**	**Total Price ($)**
River outfall structure[d]	1	LS	184,000		184,000
Mechanical valves and appurtenances	1	LS	50,000		50,000
Estimating contingency	10	%		+	99,000
Capital costs subtotal					1,081,000
Contractor overhead and profit	15	%			162,000
Sales tax	8.8	%		+	109,000
Direct construction cost subtotal					**1,352,000**
Easement allowance[e]	2700	LF	14		**38,000**
Allied Costs					
Consultant services					
30% design					92,000
Final design					110,000
CM support services	4	%			56,000
KC admin and other allied costs				+	100,000
Allied costs subtotal					**358,000**
Total Conveyance/Discharge Project Costs (Feb 2005)					**1,748,000**
Total Project Cost					**14,217,000**

General Notes:

(1) The cost estimate herein is based on our perception of current conditions. The estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures.

(2) Carollo Engineers has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies.

(3) Carollo Engineers cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the costs presented herein.

(4) General Exclusions: All costs associated with the identification/mitigation of hazardous materials. All costs associated with historical/cultural discoveries on site. All costs associated with dewatering.

Table 7.15 Conceptual Level Cost Estimate Carnation Wastewater Treatment Facility King County Department of Natural Resources and Parks					
Description	**Quantity of units**	**Unit**	**Unit Price ($/unit)**	**Installation Price ($)**	**Total Price ($)**

Footnotes:

a. Foundation pilings are not anticipated to be required for the project based on recent soil borings on the site.

b. Asphalt-paved roads with no curbs or gutters. Open-cut trenching costs include 10-ft-wide pavement demolition, earthwork, and pavement restoration. Assumes excavation to an average of 5 ft below ground surface, traffic control, and 50% native backfill above pipe zone. Does not assume costs for shoring.

c. Open-cut trenching costs include earthwork and gravel surface restoration. Assumes excavation to an average of 5 ft below ground surface and use of 75% native backfill above pipe zone. Does not assume costs related to shoring. Easement allowance for conveyance right-of-way listed separately.

d. Assumes installation of 280 ft of 8-inch-diameter horizontal ductile iron pipe, vertical pipe with a diffuser check valve, and in-water work.

e. Allows for 30-foot temporary easement in addition to 10-foot permanent easement from Bagwell Street to NE 60th Street.

Date: 3/8/2005

Calculations By: S. Leung

Checked: B. Einfeld

CY = cubic yard	LS = lump sum
DI = ductile iron	SF = square foot
LF = linear feet	

7.9 Future Expansion

The north and east physical boundaries of the recommended CWWTF site are constrained by the setback requirements from the property lines. The City's vacuum pump station bounds the facility to the south. By 2017, the City will have reached residential saturation within its UGA, with only additional employment-related flows anticipated. These additional employment-related flows and loads will likely represent only a small increase in flow to the CWWTF.

The CWWTF can be expanded to accommodate potential future treatment processes that may be required due to additional loads or new regulations. The current facility layout identifies potential locations for an additional aeration basin and equipment for mechanical solids dewatering and chemical addition for phosphate removal. If the City chooses to implement non-potable reuse either within the City and/or to enhance the SWA in the future, the river outfall can serve as the alternative discharge method to meet the *Washington Reclamation and Reuse Standards*.[311]

Notes

[255] City of Carnation, "Carnation Municipal Code: Title 15 Land Use", http://www.ci.carnation.wa.us/Carnation_Municipal_Code/Title_15/index.html, (accessed March 10, 2005).
[256] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[257] Washington Department of Ecology, *Washington Reclamation and Reuse Standards*, 1997.
[258] Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.
[259] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[260] Lucchetti, G., "Salmonid Use of the Snoqualmie River - Tolt Delta Reach", King County Department of Natural Resources and Parks, 2005.
[261] Lucchetti, G., "Salmonid Use of the Snoqualmie River - Tolt Delta Reach", King County Department of Natural Resources and Parks, 2005.
[262] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[263] Carollo Engineers, *Technical Memorandum No. 11 - Discharge Alternatives*, 2004.
[264] Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.
[265] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[266] Steve Gilbert, KCDNRP, personal communication, February 2005.
[267] Bill Fox, Cosmopolitan Engineers, personal communication, February 21, 2005.
[268] Penhallegon Associates Consulting Engineers, Inc, Snoqualmie River profile survey near Carnation, February 17, 2005.
[269] Bill Fox, Cosmopolitan Engineers, personal communication, February 21, 2005.
[270] Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.
[271] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
[272] *Water quality standards for surface waters of the state of Washington*, *WAC 173-201A* (2003).
[273] King County Department of Natural Resources and Parks, Water and Land Resources Division, *Draft Existing Water Quality Conditions in the Snoqualmie River near the City of Carnation: 2003-2004 Monitoring Results*, February 2005.
[274] Lucchetti, G., "Salmonid Use of the Snoqualmie River - Tolt Delta Reach", King County Department of Natural Resources and Parks, 2005.
[275] Lucchetti, G., "Salmonid Use of the Snoqualmie River - Tolt Delta Reach", King County Department of Natural Resources and Parks, 2005.
[276] Bob Pfeifer, Washington Department of Fish and Wildlife, Carnation WWTP EIS Scoping Comments, Letter dated August 11, 2003.
[277] Lucchetti, G., "Salmonid Use of the Snoqualmie River - Tolt Delta Reach", King County Department of Natural Resources and Parks, 2005.
[278] Cosmopolitan Engineering Group, *Technical Memorandum No. 12 - River Outfall*, 2004.
[279] Lucchetti, G., "Salmonid Use of the Snoqualmie River - Tolt Delta Reach", King County Department of Natural Resources and Parks, 2005.
[280] Carollo Engineers, *Technical Memorandum No. 14 - Plant Alternatives Development*, 2004.
[281] *Water quality standards for surface waters of the state of Washington*, *WAC 173-201A* (2003).
[282] King County Department of Natural Resources and Parks, Wastewater Treatment Division, *Final Environmental Impact Statement for the Carnation Treatment Facility,* October 2004.
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